DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

[Docket No. NHTSA–2021–0002]

New Car Assessment Program

AGENCY: National Highway Traffic Safety Administration (NHTSA), Department of Transportation (DOT).

ACTION: Request for comments (RFC).

SUMMARY: NHTSA's New Car Assessment Program (NCAP) provides comparative information on the safety performance of new vehicles to assist consumers with vehicle purchasing decisions and to encourage safety improvements. In addition to star ratings for crash protection and rollover resistance, the NCAP program recommends particular advanced driver assistance systems (ADAS) technologies and identifies the vehicles in the marketplace that offer the systems that pass NCAP performance test criteria for those systems. This notice proposes significant upgrades to NCAP, first, by proposing to add four more ADAS technologies to those NHTSA currently recommends. The new technologies are blind spot detection, blind spot intervention, lane keeping support, and pedestrian automatic emergency braking. Other plans on updating NCAP are discussed in the Supplementary Information.

DATES: Comments should be submitted no later than May 9, 2022.

ADDRESSES: Comments should refer to the docket number above and be submitted by one of the following methods:

- *Federal Rulemaking Portal: https://www.regulations.gov.* Follow the online instructions for submitting comments.
- *Mail:* Docket Management Facility, U.S. Department of Transportation, 1200 New Jersey Avenue SE, West Building Ground Floor, Room W12–140, Washington, DC 20590–0001.
- *Hand Delivery:* 1200 New Jersey Avenue SE, West Building Ground Floor, Room W12–140, Washington, DC, between 9 a.m. and 5 p.m. ET, Monday through Friday, except Federal Holidays.
- *Instructions:* For detailed instructions on submitting comments, see the Public Participation heading of the **SUPPLEMENTARY INFORMATION** section of this document. Note that all comments received will be posted without change to *https://www.regulations.gov,* including any personal information provided.
- *Privacy Act:* Anyone can search the electronic form of all comments received in any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.). You may review DOT's complete Privacy Act Statement in the **Federal Register** published on April 11, 2000 (65 FR 19477–78) or at *https://www.transportation.gov/privacy.* For access to the docket to read background documents or comments received, go to *https://www.regulations.gov* or the street address listed above. Follow the online instructions for accessing the dockets.

FOR FURTHER INFORMATION CONTACT: For technical issues, you may contact Ms. Jennifer N. Dang, Division Chief, New Car Assessment Program, Office of Crashworthiness Standards (Telephone: 202–366–1810). For legal issues, you may contact Ms. Sara R. Bennett, Office of Chief Counsel (Telephone: 202–366–2992). You may send mail to either of these officials at the National Highway Traffic Safety Administration, 1200 New Jersey Avenue SE, West Building, Washington, DC 20590–0001.

SUPPLEMENTARY INFORMATION: This notice also proposes changes (including an increase in stringency) to the test procedures and performance criteria for the four currently recommended ADAS technologies in NCAP to enable enhanced evaluation of their capabilities in current vehicle models and to harmonize with other consumer information programs. Second, this notice describes (but does not propose at this time) how NHTSA could rate vehicles equipped with these ADAS technologies and requests comment on how best to develop this rating system. Third, NHTSA seeks (but does not propose at this time) to provide a crash avoidance rating at the point of sale on a vehicle's window sticker, consistent with the 2015 Fixing America's Surface Transportation (FAST) Act, and discusses ways of implementing the program, including a potential process for updating such information. Fourth, as part of a new NHTSA approach to NCAP, NHTSA is proposing a ''roadmap'' of the Agency's plans to upgrade NCAP in phases over the next several years and presents the roadmap for comment. Fifth, as another first for NCAP, NHTSA is considering utilizing NCAP to raise consumer awareness of certain safety technologies that may have the potential to help people make safe driving choices. This information may be of particular interest to parents or other caregivers shopping for a vehicle for a new or inexperienced driver in the household, or parents wanting to know more about rear seat alerts for hot car/heatstroke. Sixth and finally, this RFC discusses NHTSA's ideas for updating several programmatic aspects of NCAP to improve the program. The proposal on ADAS technologies and the aforementioned initiatives pave the way for the Agency to focus on a much broader safety strategy, including fulfilling not only the 2015 FAST Act directive but also the recent mandates included in Section 24213 of the November 2021 Bipartisan Infrastructure Law, enacted as the Infrastructure Investment and Jobs Act, to improve road safety for motor vehicle occupants as well as other vulnerable road users.

Table of Contents

I. Executive Summary

NHTSA's New Car Assessment Program (NCAP) supports NHTSA's mission to reduce the number of fatalities and injuries that occur on U.S. roadways. NCAP, like many other NHTSA programs, has contributed to significant reductions in motor vehicle fatalities. In the decade prior to the 1978 start of NCAP, fatalities from motor vehicle crashes exceeded 50,000 annually. In 2019, 36,096 people still lost their lives on U.S. roads. Passenger vehicle occupant fatalities decreased from 32,225 in 2000 to 22,215 in 2019.[1] This reduction is notable, particularly in light of the fact that the total number of vehicle miles traveled (VMT) in the U.S. has increased over time. However, during that same timeframe, pedestrian fatalities increased by 33 percent, from 4,739 in 2000 to 6,205 in 2019.[2] Furthermore, a statistical projection of traffic fatalities for the first half of 2021 shows that an estimated 20,160 people died in motor vehicle traffic crashes—the highest number of fatalities during the first half of the year since 2006, and the highest half-year percentage increase in the history of data recorded by the Fatality Analysis Reporting System (FARS).[3] In addition, the projected 11,225 fatalities during the second quarter of 2021 represents the highest second quarter fatalities since 1990, and the highest quarterly percentage change (+23.1 percent) in FARS data recorded history. Preliminary data reported by the Federal Highway Administration (FHWA) show that VMT in the first half of 2021 rebounded from a large pandemic-related dip that occurred in the first half of 2020, increasing by 173.1 billion miles, or about a 13 percent increase over the comparable period in 2020. The fatality rate for the first half of 2021 increased to 1.34 fatalities per 100 million VMT, up from the projected rate of 1.28 fatalities per 100 million VMT in the first half of 2020. Early evidence suggests that these fatality rates have increased as a result of increases in risky behaviors like driving and riding while unbelted, impaired driving, and speeding.[4] Although there have been notable gains in automotive safety over the past fifty years, far more work must be done.

This notice discusses how NCAP can support NHTSA's mission through its multi-faceted initiatives and broad safety strategies to address vehicle safety involving motor vehicle occupants, other vulnerable road users, and safe driving choices to further reduce injuries and fatalities occurring on the nation's roads. As stated in the Department of Transportation's National Roadway Safety Strategy, proposals to update NCAP are expected to emphasize safety features that protect people both inside and outside of the vehicle, and may include consideration of pedestrian protection systems, better understanding of impacts to pedestrians (*e.g.,* specific considerations for children), and automatic emergency braking and lane keeping assistance to benefit bicyclists and pedestrians. In a first-of-its-kind focus—especially relevant in light of increases in fatalities caused by risky driving behaviors—this notice seeks comment on how automakers could encourage consumers to choose safety technologies that could prevent risky behaviors from occurring in the first place. This notice also proposes significant upgrades to NCAP by adding four additional crash avoidance technologies (also termed ADAS throughout this notice) to the program, increasing the stringency of the tests for currently recommended ADAS technologies in NCAP for enhanced evaluation of their current capabilities, and exploring, for the first time, expanding NCAP to include safety for road users outside of the vehicle. Finally, this document presents a roadmap of NHTSA's current plans to upgrade NCAP in phases over the next several years.

Many of these efforts align with Section 24213 of the Bipartisan Infrastructure Law, enacted as the Infrastructure Investment and Jobs Act[5] and signed on November 15, 2021. First, this RFC, once finalized, fulfills the requirements of Section 24213(a) of the Bipartisan Infrastructure Law because NHTSA intends for the addition of the four technologies proposed in this RFC to "finalize the proceeding for which comments were requested" on December 16, 2015.[6] Specifically, the finalization of this RFC will close the December 16, 2015 proceeding and notice. While NHTSA has future plans described in the roadmap that the Agency discussed in the December 16, 2015 notice, none are considered an extension of the December 16, 2015 proceeding, though all information previously collected by NHTSA may be used in the development of future notices.

Second, this RFC fulfills portions of the requirements in Section 24213(b) of the Bipartisan Infrastructure Law that mandates the Agency "publish a notice, for the purposes of public comment, to establish a means for providing consumer information relating to advanced crash-avoidance technologies" within one year of enactment that includes: (1) An appropriate methodology for determining which advanced crash avoidance technologies should be included in the information, (2) performance test criteria for use by manufacturers in evaluating those technologies, (3) a distinct rating system involving each technology, and (4) updating overall vehicle ratings to include the new rating. Through this RFC, NHTSA is proposing four additional advanced crash avoidance technologies[7] for inclusion in NCAP, proposing the test criteria for evaluating the advanced crash avoidance technologies, and seeking comment on the future development of a crash avoidance rating system. NHTSA described in detail why it chose the four

---

[1] Traffic Safety Facts 2019 "*A Compilation of Motor Vehicle Crash Data.*" U.S. Department of Transportation. National Highway Traffic Safety Administration.

[2] Traffic Safety Facts 2000 "*A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System.*" U.S. Department of Transportation. National Highway Traffic Safety Administration.

[3] National Center for Statistics and Analysis. (2021, October), *Early Estimate of Motor Vehicle Traffic Fatalities for the First Half (January–June) of 2021.* (Traffic Safety Facts. Report No. DOT HS 813 199), Washington, DC: National Highway Traffic Safety Administration.

[4] See *https://www.nhtsa.gov/press-releases/2020-fatality-data-show-increased-traffic-fatalities-during-pandemic.*

[5] (Pub. L. 117–58).

[6] *Id.* at Section 24213(a); the notice referred to in the Bipartisan Infrastructure Law is 80 FR 78522 (Dec. 16, 2015). This is the notice that will be finalized once the final decision notice for today's RFC is published.

[7] This notice refers to the advanced crash avoidance technologies as Advanced Driver Assistance Systems (ADAS) technologies.

technologies that it did and how those technologies meet NHTSA's established criteria for inclusion in NCAP. Since NHTSA is proposing the addition of four advanced crash avoidance technologies and test criteria for evaluating those technologies, NHTSA meets two of the four requirements for fulfillment of the Advanced Crash Avoidance section of Sec. 24213(b).

Section 24213(b) of the law also requires that the Agency publish a notice "to establish a means for providing to consumers information relating to pedestrian, bicyclist, or other vulnerable road user safety technologies" within one year of enactment. This notice must meet requirements very similar to the advanced crash avoidance notice mentioned above. Since NHTSA is today proposing to include pedestrian automatic emergency braking (PAEB) in the program and is including test criteria for evaluating PAEB, NHTSA meets two of the four requirements for fulfillment of the Vulnerable Road User Safety section of Sec. 24213(b). The remaining requirements will be fulfilled once NHTSA proposes and then finalizes a new rating system for the crash avoidance technologies in NCAP. The law also requires that NHTSA submit reports to Congress on its plans for fulfilling the abovementioned requirements. NHTSA plans to fulfill these reporting requirements in a timely manner.

Third, this RFC, once finalized, fulfills the requirements of Section 24213(c) for NHTSA to establish a roadmap for implementation of NCAP changes that covers a term of ten years, with five year mid-term and five year long-term components, and with updates to the roadmap at least once every four years to reflect new Agency interests and public comments. The first roadmap must be completed within one year of the law's enactment. Once finalized, the roadmap on future updates to NCAP proposed in this RFC in its entirety would fulfill the ten-year roadmap requirement, as some proposed initiatives will be considered in NCAP in the first five years while others will be proposed in the second half of the ten-year plan. The details and analysis of this fulfillment are available in the Roadmap section of this RFC.

Fourth, this RFC, once finalized, will fulfill a provision in Section 24213(c) of the Bipartisan Infrastructure Law that requires NHTSA to make the roadmap available for public comment and to consider the public comments received before finalizing the roadmap. These provisions are in accordance with the Agency's current practice for updating NCAP and will be followed to finalize the roadmap. Section 24213(c) of the Law also requires that NHTSA identify opportunities where NCAP would "benefit from harmonization with third-party safety rating programs." The Agency is taking steps to harmonize with existing consumer information rating programs where possible, and when appropriate, as noted in various sections of this RFC.

Fifth, Section 24213(c) of the Law requires the Agency to engage with stakeholders with diverse backgrounds and viewpoints not less than annually to develop future roadmaps. Again, this provision is in accordance with the Agency's current practice.

Components of the Notice

There are six main parts to this notice:

1. Proposes to add four new ADAS technologies to NCAP and updates to current NCAP test procedures,
2. Discusses the Agency's plan to develop a new rating system for advanced driver assistance technologies,
3. Describes steps to list the crash avoidance rating information on the vehicle's window sticker (the Monroney label) at the point of sale,
4. Describes roadmap of the Agency's plans to update NCAP in phases over the next ten years,
5. Requests comments on expanding NCAP to provide consumer information on safety technologies that could help people drive safer by preventing or limiting risky driving behavior, and
6. Discusses NHTSA's ideas for updating several programmatic aspects of NCAP to improve the program as a whole.

Each of the aforementioned aspects of the notice are described in greater detail that follows. First, the notice discusses in detail the Agency's proposed upgrade to add four more ADAS technologies to those currently recommended by NHTSA through NCAP and that are highlighted on the NHTSA website. Since 2010, NCAP has recommended four kinds of ADAS technologies to prospective vehicle purchasers, and has identified to shoppers the vehicles that have these technologies and that meet NCAP performance test criteria.[8] The current technologies are forward collision warning (FCW), lane departure warning (LDW), crash imminent braking (CIB), and dynamic brake support (DBS) (with the latter two collectively referred to as "automatic emergency braking).[9] This notice proposes changes (including an increase in stringency) to the test procedures and performance criteria for LDW, CIB, DBS, and FCW to (1) enable enhanced evaluation of their capabilities in current vehicle models, (2) reduce test burden, and (3) harmonize with other consumer information programs. This notice also describes and proposes four more ADAS technologies: Blind spot detection, blind spot intervention, lane keeping support, and pedestrian automatic emergency braking.

These four new ADAS technologies are candidates for NCAP because data indicate they satisfy NHTSA's four prerequisites for inclusion in the program. The prerequisites are: (1) The update to the program addresses a safety need; (2) there are system designs (countermeasures) that can mitigate the safety problem; (3) existing or new system designs have safety benefit potential; and (4) a performance-based objective test procedure exists that can assess system performance. In order to address (1), a safety need, the Agency inherently looks first to address injuries and fatalities stemming from "high-frequency and high-risk crash types"—as these crashes command the largest safety need and thus may also afford the biggest potential benefit. NHTSA does not calculate relative costs and benefits when considering inclusion in NCAP as it is a non-regulatory consumer information program. NHTSA discusses in this notice how each of the proposed ADAS technologies meets the four prerequisites. As explained in detail in this notice, the four new ADAS technologies proposed in NCAP are the only technologies that the Agency believes meet the four prerequisites for inclusion at this time. Each technology has demonstrated the ability to successfully mitigate high frequency and high-risk crash types. With the proposal to include pedestrian automatic emergency braking, NCAP would be expanded, for the first time, to include safety for people outside of the vehicle.

Second, this notice discusses the Agency's plan to develop a future rating system for new vehicles based on the availability and performance of all the NCAP-recommended crash avoidance technologies. Currently, NCAP only

---

[8] NCAP only indicates that a vehicle has a recommended technology when NHTSA has data verifying that the technology meets the minimum performance requirements set by NHTSA for acceptable performance. If a vehicle's ADAS is reported to have satisfied the performance requirements using the test methods specified by the Agency, then NHTSA uses a checkmark system to indicate on the NHTSA website that the vehicle is equipped with the technology. Each year, NHTSA also selects a sample of vehicles from that model year to verify ADAS system performance by performing its own tests.

[9] *https://www.nhtsa.gov/equipment/driver-assistance-technologies.*

recommends crash avoidance technologies to shoppers, and identifies the vehicles that offer the recommended technologies that pass NCAP system performance criteria. Unlike its crashworthiness and rollover protection programs that offer a combined rating based on vehicle performance in frontal, side, and rollover tests, the NCAP crash avoidance program does not currently have a rating system to differentiate the performance of ADAS technologies. NHTSA seeks to remedy this by developing a rating system for ADAS technologies to provide purchasers improved data with which to compare and shop for vehicles, and to spur improved vehicle performance. Accordingly, this document seeks public input on how best to develop this rating system.

Third, this notice announces NHTSA's steps to list the crash avoidance rating information on the vehicle's window sticker (the Monroney label) at the point of sale, as directed by the FAST Act.[10] NHTSA requests comment on ideas for the Monroney label information. Research is underway to maximize the effectiveness of the information in informing purchasing decisions. A follow-on notice will propose the crash avoidance rating system and explain how NHTSA would use the ratings. NHTSA will consider the comments received on this notice in conjunction with the information gained from the consumer research, to develop a proposal for a revised label. To help shoppers make more informed purchasing decisions, NHTSA also plans to provide fuel economy and greenhouse gas rating information with the NHTSA safety ratings, not only at the point of sale but also on the NHTSA website.

Fourth, as part of a new approach to advancing NCAP, NHTSA has developed a roadmap of the Agency's current plans to upgrade NCAP in phases over the next several years. The roadmap sets forth NHTSA's near-term and longer-term strategies for upgrading NCAP. The roadmap takes a gradual approach, which contemplates NHTSA's issuing proposed upgrades in phases, as the technologies mature to readiness for proposed inclusion in NCAP. Following a proposal will be a final decision document that responds to comments and provides NHTSA's decisions for that phase of NCAP updates, including the lead time provided for the implementation. The roadmap presents an estimated timeframe of the phased request for comment (RFC) notices.

Fifth, this notice also considers expanding NCAP to provide consumer information on safety technologies that could help people drive safer by preventing or limiting risky driving behavior. The Agency is examining the possibility of expanding NCAP to include technologies that promote NHTSA's continuing efforts to combat unsafe driving behaviors, such as distracted and impaired driving, riding in a vehicle unrestrained, and speeding. NHTSA currently uses many approaches to reduce dangerous driving behaviors, including high visibility enforcement and advertising campaigns like ''Click it or Ticket'' and ''Buzzed Driving is Drunk Driving.'' These campaigns have succeeded in reducing, but not eliminating, human causes of crashes and there is some evidence that their success has reached a plateau. NHTSA is considering how NCAP can promote technologies that would reduce unsafe driving or riding behavior like distracted and impaired driving, speeding, or riding in a vehicle unrestrained by targeting the human behaviors most likely to lead to crashes. This information may be of particular interest to parents or other caregivers who are shopping for a vehicle for a new or inexperienced driver in the household, or caregivers wanting to know more about rear seat alerts for hot car/heatstroke.

Sixth and finally, this RFC discusses NHTSA's ideas for updating several programmatic aspects of NCAP to improve the program as a whole. NHTSA requests comment on the Agency's ideas for revising the 5-star safety ratings program. This document also discusses ways NHTSA would like to update the existing ADAS technology program components, outlines challenges the Agency has encountered relating to manufacturer self-reported data, and proposes possible solutions to those problems. Lastly, the RFC discusses (1) updates to the NCAP website to improve the dissemination of vehicle safety information to consumers and (2) the development of an NCAP database to modernize the operational aspects of the program, including a new vehicle information submission process for vehicle manufacturers.

This RFC includes numbered questions throughout the notice that highlight specific topics on which NHTSA seeks comments. Although several questions may be posed un-numbered within the body of certain sections, these un-numbered questions are reiterated at the conclusion of the topic discussion and in Appendix B. To help ensure that NHTSA is able to address all comments received, the Agency requests that commenters provide corresponding numbering in their responses.

II. Background

NHTSA established its NCAP in 1978 in response to Title II of the Motor Vehicle Information and Cost Savings Act of 1972. When the program first began providing consumers with vehicle safety information derived from frontal crashworthiness testing, attention within the industry to vehicle safety was relatively new. Today's consumers are much more interested in vehicle safety, and this has become one of the key factors in vehicle purchasing decisions.[11] Vehicle manufacturers have responded to these consumer demands by offering safer vehicles that incorporate enhanced safety features. This has resulted in improved vehicle safety performance in NCAP, which has historically translated into higher NCAP star ratings.

Over the years, NHTSA began to incorporate ADAS technologies into NCAP's crash avoidance program. In 2007, NHTSA, for the first time, issued an RFC exploring the addition of ADAS technologies in NCAP.[12] Later, based on feedback received from written and oral comments, NHTSA published a final decision[13] expanding NCAP to include certain ADAS technologies and specific performance thresholds that a NHTSA-recommended ADAS system must meet. Beginning with model year 2011, the Agency began recommending on its website forward collision warning (FCW), lane departure warning (LDW), and electronic stability control (ESC),[14] and identified to shoppers which vehicles have the technologies that meet NCAP's performance requirements. NHTSA updated NCAP further to include crash imminent braking (CIB) and dynamic braking support (DBS)

---

[10] This Act requires NHTSA to promulgate a rule to require vehicle manufacturers to include crash avoidance information next to the crashworthiness information on vehicle window stickers (Monroney labels).

[11] See *www.regulations.gov,* See *www.regulations.gov,* Docket No. NHTSA–2020–0016 for a report of ''New Car Assessment Program 5-Star Quantitative Consumer Research.''

[12] 72 FR 3473 (January 25, 2007). The RFC included a request for comments on a NHTSA report titled, ''The New Car Assessment Program (NCAP); Suggested Approaches for Future Enhancements.''

[13] 73 FR 40016 (July 11, 2008).

[14] ESC was removed from the Agency's list of recommended ADAS technologies through NCAP beginning in model year 2014 when the technology became mandated under FMVSS No. 126, ''Electronic stability control.'' NHTSA also included rear video systems in its list of recommended technologies under NCAP from model years 2014 to 2017 and removed that technology from its list when it became mandated under FMVSS No. 111, ''Rear Visibility.''

technologies, beginning with model year 2018 vehicles.

This RFC continues those efforts. Through several notices and public meetings, NHTSA has continued discussions with stakeholders about which technologies should be included in NCAP and the minimum performance thresholds those technologies should meet. NHTSA has set forth in Appendix C to this RFC a detailed history of the requests for comment, public meetings, and other relevant events that underlie this notice.

The last RFC NHTSA published to discuss potential changes to NCAP was published in 2015. It was broad in subject matter and sought comment on NCAP's potential use of enhanced tools and techniques for evaluating the safety of vehicles, generating star ratings, and stimulating further vehicle safety developments.[15] On the crashworthiness front, the RFC sought comment on establishing a new frontal oblique test and on using more advanced crash test dummies in all tests. The RFC also sought comment about establishing a new crash avoidance rating category and including nine advanced crash avoidance technologies. Additionally, the RFC sought comment on establishing a new pedestrian protection rating category involving the use of adult and child head, upper leg, and lower leg impact tests and adding two new pedestrian crash avoidance technologies. The RFC sought comment on combining the three categories (crash avoidance, crashworthiness, and pedestrian protection) into one overall 5-star rating. NHTSA also received comments at two public hearings, one in Detroit, Michigan, on January 14, 2016, and the second at the U.S. DOT Headquarters in Washington, DC, on January 29, 2016. The numerous comments received on the RFC are discussed in a section below.

In October 2018, NHTSA hosted a third public meeting to re-engage stakeholders and seek up-to-date input to help the Agency plan the future of NCAP.[16] The Agency has also been working to finalize its research efforts on pedestrian crash protection, advanced anthropomorphic test devices (crash test dummies) in frontal and side impact tests, a new frontal oblique crash test, and an updated rollover risk curve. As discussed in the roadmap, NHTSA plans to upgrade the NCAP crashworthiness program in phases over the next several years with the knowledge it has acquired from the research programs.

III. ADAS Performance Testing Program

ADAS technologies have the potential to increase safety by preventing crashes or mitigating the severity of crashes that might otherwise lead to injury and death. NCAP currently conducts performance verification tests for four ADAS technologies: Forward collision warning (FCW), lane departure warning (LDW), crash imminent braking (CIB), and dynamic brake support (DBS). CIB and DBS are collectively referred to as automatic emergency braking (AEB). Vehicles that are equipped with one or more of these systems and pass NCAP's performance test requirements are listed as ''Recommended'' on NHTSA's website. When the Agency first began recommending FCW and LDW systems for model year 2011 vehicles, the fitment rate for these systems was less than 0.2 percent (where ''fitment rate'' means the percent of vehicles equipped with a particular ADAS system). For model year 2018 vehicles, 38.3 percent were equipped with FCW and 30.1 percent were equipped with LDW.[17] Providing vehicle safety information through NCAP can be an effective approach to advance the deployment of safer vehicle designs and technology in the U.S. market, inform consumer choices, and encourage adoption of new technologies that have life-saving potential.

With this notice, NHTSA is proposing to incorporate four additional ADAS technologies into NCAP's crash avoidance program: Lane keeping support (LKS), pedestrian automatic emergency braking (PAEB), blind spot warning (BSW), and blind spot intervention (BSI). Each of these technologies meets the Agency's established criteria for inclusion in NCAP: (1) The technology addresses a safety need; (2) system designs exist that can mitigate the safety problem; (3) the technology provides the potential for safety benefits; and (4) a performance-based objective test procedure exists that can assess system performance.[18] Details about how each of the proposed ADAS technologies addresses a safety need (criterion 1) will be discussed immediately below, while the remaining criteria will be discussed in the relevant sections under each technology.

To gain an understanding of the safety need that current ADAS technologies may address, NHTSA analyzed crash data for 84 mutually exclusive pre-crash scenarios.[19] The pre-crash scenarios used in the Agency's analysis were devised using a typology[20] concept[21] published by the Volpe National Transportation Systems Center (Volpe), which categorizes crashes into dynamically distinct scenarios based on pre-crash vehicle movements and critical events. As detailed in the referenced March 2019 report, NHTSA mapped the pre-crash scenario typologies to twelve currently available ADAS technologies[22] believed to potentially address certain pre-crash scenarios by assisting the driver to avoid or mitigate a crash. These mappings served to define the corresponding crash populations (*i.e.,* target crash populations).

Since several ADAS technologies presently available on passenger vehicles[23] are designed to mitigate the same crash scenarios, NHTSA first grouped the technologies with similar design intent into categories. The five technology categories that resulted from this grouping process include: (1) Forward collision prevention, (2) lane keeping, (3) blind spot detection, (4) forward pedestrian impact, and (5) backing collision avoidance. As shown in Table A–6, these categories address the following high-level crash types: (1) Rear-end; (2) rollover, lane departure, and road departure; (3) lane change/merge; (4) pedestrian; and (5) backing, respectively. Of the original 84 pre-crash scenarios studied, we mapped 34 relevant pre-crash scenario typologies to the five resulting technology categories that represented these crash types.

The forward collision prevention category included three ADAS technologies: Forward collision warning, crash imminent braking, and dynamic brake support (FCW, CIB, and

---

[15] 80 FR 78521 (Dec. 16, 2015).

[16] October 1, 2018.

[17] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

[18] 78 FR 20599 (Apr. 5, 2013).

[19] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

[20] A typology is the study or analysis of something, or the classification of something, based on types or categories.

[21] Swanson, E., Foderaro, F., Yanagisawa, M., Najm, W.G., & Azeredo, P. (2019), *Statistics of light-vehicle pre-crash scenarios based on 2011–2015 national crash data* (Report No. DOT HS 812 745), Washington, DC: National Highway Traffic Safety Administration.

[22] The twelve ADAS technologies were as follows: FCW, DBS, CIB, LDW, LKS, lane centering assist (LCA), BSW, BSI, lane change/merge warning, PAEB, RAB, and rear cross-traffic alert.

[23] Passenger vehicles were defined as cars, crossovers, sport utility vehicles (SUVs), light trucks, and vans having a gross vehicle weight rating (GVWR) of 10,000 pounds or less.

DBS, respectively). The lane keeping category included lane departure warning (LDW), lane keeping support (LKS),[24] and lane centering assist (LCA). The blind spot detection category included blind spot warning (BSW),[25] blind spot intervention (BSI), and lane change/merge warning. The forward pedestrian impact avoidance category included pedestrian automatic emergency braking (PAEB). Lastly, the backing collision avoidance category included rear automatic braking (RAB) and rear cross-traffic alert (RCTA). These ADAS technologies are characterized as SAE International (SAE) Level 0–1 [26] driving automation systems.

NHTSA derived target crash populations for each of the five technology categories using 2011 to 2015 Fatality Analysis Reporting System (FARS) and National Automotive Sampling System General Estimates System (NASS GES) data sets, which serve as records of police-reported fatal and non-fatal crashes, respectively, on the nation's roads. For a given technology category, we compiled data for each of the corresponding pre-crash scenarios to generate target crash populations surrounding the number of crashes, fatalities, non-fatal injuries, and property-damage-only vehicles (PDOVs).[27] See Table 1 for a breakdown of target crash populations for each technology category.

TABLE 1—SUMMARY OF TARGET CRASHES BY TECHNOLOGY GROUP

Safety systems	Crashes	Fatalities	MAIS 1–5 injuries	PDOVs
1. FCW/DBS/CIB	1,703,541 (29.4%)	1,275 (3.8%)	883,386 (31.5%)	2,641,884 (36.3%)
2. LDW/LKA/LCA	1,126,397 (19.4%)	14,844 (44.3%)	479,939 (17.1%)	863,213 (11.9%)
3. BSW/BSI/LCM	503,070 (8.7%)	542 (1.6%)	188,304 (6.7%)	860,726 (11.8%)
4. PAEB	111,641 (1.9%)	4,106 (12.3%)	104,066 (3.7%)	6,985 (0.1%)
5. RAB/RvAB [28] RCTA	148,533 (2.6%)	74 (0.2%)	35,268 (1.3%)	231,317 (3.2%)
Combined	3,593,18 (62%)	20,841 (62.2%)	1,690,963 (60.3%)	4,604,125 (63.3%)

It is important to note that target crash populations for the five technology categories covered 62 percent of all crashes. Crossing path crashes, which also represented a large crash population and a significant number of fatalities, were not part of our analysis because we are not aware of a currently available ADAS technology that can effectively mitigate this crash type.[29] However, there are emerging safety countermeasures that hold potential to address some portion of these crashes in the future and these technologies will be considered for NCAP as they mature. These include intersection safety assist (ISA) systems that use onboard sensors with a wide field of view (*e.g.*, cameras, lidar, radar) as well as vehicle communications systems.[30] [31] Loss-of-control in single-vehicle crashes [32] also had a relatively high target population and fatality rate,[33] but were not included because, aside from electronic stability control (ESC) systems, which are mandated,[34] the Agency is not aware of an ADAS technology that effectively prevents this crash type and also meets NHTSA's criteria for inclusion in NCAP at this time.[35]

Of the pre-crash typologies included in NHTSA's March 2019 study, rear-end collisions were found to be the most common crash type with an annual average of 1,703,541 crashes. Rear-end collisions represented 29.4 percent of all annual crashes (5,799,883), followed by lane keeping typologies (1,126,397 crashes or 19.4 percent), and those relating to blind spot detection (503,070 crashes or 8.7 percent). Backing crashes (148,533) represented 2.6 percent of all crashes, followed by forward pedestrian crashes (111,641) at 1.9 percent.

Rear-end collisions also had the highest number of Maximum Abbreviated Injury Scale (MAIS) [36] 1–5 injuries at 883,386, which represented 31.5 percent of all non-fatal injuries (2,806,260) in Table A–1. Lane keeping crashes had the second highest number of injuries at 479,939 (17.1 percent), as shown in Table A–2, and blind spot crashes had the third highest at 188,304 (6.7 percent), as shown in Table A–3. These typologies were followed by forward pedestrian crashes at 3.7

---

[24] The study uses the term ''lane keeping assist'' (LKA), but NCAP terminology differs. NCAP uses the term ''lane keeping support'' throughout this document instead.

[25] Similarly, the study uses the term ''blind spot detection'' (BSD) but NCAP uses the term blind spot warning (BSW) throughout this document instead.

[26] SAE International (2018), *Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles* (SAE J3016). Level 0: No Automation—The full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems. Level 1: Driver Assistance—The driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver performs all remaining aspects of the dynamic driving task.

[27] PDOVs are vehicles damaged in non-injury-producing crashes (*i.e.,* crashes in which vehicles only incur property damage and no occupants incur injury).

[28] Defined as reverse automatic braking in DOT HS 812 653.

[29] In its 2019 report, Volpe found that of the 5,480,886 light vehicle crashes occurring from 2011 through 2015, crossing path crashes, which totaled 1,131,273, represented 21 percent of all light vehicle crashes and 16 percent (3,972) of all fatalities (25,350).

[30] NHTSA recognizes that ISA systems are currently available on a small number of light vehicles. However, preliminary NHTSA testing has shown that current-generation ISA systems have only limited capabilities and therefore would not effectively mitigate intersection-related crashes at this time—which is one of the requirements in the four prerequisites for inclusion in NCAP.

[31] Vehicle-to-vehicle (V2V) and vehicle-to-everything (V2X) technologies have the potential to address crossing path crashes, but, while NHTSA remains strongly interested in these technologies, they are not included in the current roadmap. NHTSA is continuing to consider the various issues that bear upon the deployment path of V2X, including technological evolution and regulatory changes to the radio spectrum environment.

[32] Crash scenarios were categorized by the first sequence of a crash event. Target crashes for a technology (*e.g.,* lane-keeping crashes) were a collective of crash scenarios that are relevant to the technology. The Loss-of-control in single-vehicle scenario was defined as crashes where the first event was initiated by a passenger vehicle, and the event was coded as jackknife or traction loss. This crash scenario is mutually exclusive from those included in the lane-keeping crashes.

[33] Loss-of-control in single-vehicle crashes are about 1% of crashes and associated with 3% of fatalities.

[34] Federal Motor Vehicle Safety Standard No. 126.

[35] In its 2019 report, Volpe categorized 9 percent (470,733) of all light vehicle crashes (5,480,886) occurring from 2011 through 2015 as control loss crashes. Furthermore, 18 percent (4,456) of all fatal crashes (25,350) were due to control loss.

[36] The Abbreviated Injury Scale (AIS) is a classification system for assessing impact injury severity developed and published by the Association for the Advancement of Automotive Medicine and is used for coding single injuries, assessing multiple injuries, or for assessing cumulative effects on more than one injury. AIS ranks individual injuries by body region on a scale of 1 to 6 where 1 = minor, 2 = moderate, 3 = serious, 4 = severe, 5 = critical, and 6 = maximum (untreatable). MAIS represents the maximum injury severity, or AIS level, recorded for an occupant (*i.e.,* the highest single AIS for a person with one or more injuries). MAIS 0 means no injury.

percent and backing crashes at 1.3 percent, as shown in Table A–4.[37] [38]

NHTSA found that the lane keeping technology category, represented by rollover, lane departure, and road departure crashes, included the highest number of fatalities: 14,844, or 44.3 percent of all fatalities (33,477), as shown in Table A–2. This was followed by the forward pedestrian impact category, which included 4,106 pedestrian fatalities (12.3 percent), as shown in Table A–4. The forward collision prevention category, made up of rear-end crashes, included 1,275 fatalities (3.8 percent), as shown in Table A–1.[39] The blind spot detection technology category, represented by lane change/merge crashes, accounted for 1.6 percent of all fatalities, as shown in Table A–3. This was followed by backing crashes at 0.2 percent, as shown in Table A–5, which defined the backing collision avoidance category. The Agency notes that forward pedestrian crashes, which comprised the forward pedestrian impact category, ranked second highest for fatalities, and were the deadliest based on frequency of fatalities per crash.

In selecting the ADAS technologies to include in this proposal, the Agency wanted not only to target the most frequently occurring crash types, but also prioritize the most fatal and highest risk crashes. Based on the target crash populations studied, NHTSA believes that those represented by the forward collision prevention, lane keeping, blind spot detection, and forward pedestrian impact technology categories account for the most significant safety need.

The Agency notes that ADAS technologies representing the backing collision avoidance category (*i.e.,* RAB, RvAB, and RCTA) are not being proposed for this program update. The backing collision avoidance category did not appear in the top third for number of crashes, number of fatalities, or number of MAIS 1–5 injuries. This may be due, in part, to the fact that a significant part of this crash target population is addressed by FMVSS No. 111, ''Rear visibility.'' [40] The Agency needs additional time to assess all available real-world data and study the effects of the recent full implementation of FMVSS No. 111 prior to considering adoption of ADAS technologies designed to prevent backing crashes in NCAP. Furthermore, while the Agency acknowledges that it previously proposed adding rear automatic braking (RAB) to NCAP in the December 2015 notice, it is continuing to make changes to the RAB test procedure published in support of that proposal to address the comments received. Thus, it is not proposing to add this technology to NCAP at this time. The Agency may propose adding to NCAP ADAS technologies that address the backing pre-crash typologies as the Agency continues to analyze the real-world data and refine test procedure revisions.

Units of measure contained within this notice include meters (m), kilometers (km), millimeters per second (mm/s), meters per second (m/s), kilometers per hour (kph), feet (ft.), inches per second (in./s), feet per second (ft./s), miles per hour (mph), seconds (s), and kilograms (kg).

A. Lane Keeping Technologies

A study of the 2005 through 2007 fatal crashes [41] from the National Motor Vehicle Crash Causation Study (NMVCCS) [42] identified that 42 percent of lane departure crashes (*i.e.,* where the driver left the lane of travel prior to the crash) resulted in a rollover and 37 percent resulted in an opposite direction crash.

After analyzing NHTSA's 2019 target population study, NHTSA believes that lane keeping technologies such as lane departure warning (LDW), lane keeping support (LKS), and lane centering assist (LCA), can address ten pre-crash scenarios including the prevention or mitigation of roadway departures and crossing the centerline or median (*i.e.,* opposite direction crashes). These pre-crash scenarios represented on average 1.13 million crashes annually or 19.4 percent of all crashes that occurred on U.S. roadways, and resulted in 14,844 fatalities and 479,939 MAIS 1–5 injuries, as shown in Table A–2. This equals 44.3 percent of all fatalities and 17.1 percent of all injuries recorded.[43] [44]

NCAP currently provides information on the performance of LDW, one of the lane keeping ADAS technologies. LDW was introduced in the program in 2010 for model year 2011 vehicles.[45] At the time, the fitment rate for LDW was less than 0.2 percent. In model year 2018, it was 30.1 percent.[46] Although the adoption rate for LDW has increased over this period, it has not increased as significantly as the fitment rate for forward collision warning (FCW), which saw an approximate 40 percent increase over the same time period. A possible explanation regarding the lower fitment rate for LDW will be discussed in the next section. A second lane keeping ADAS technology that the Agency believes is appropriate for inclusion in NCAP is LKS. NHTSA believes that LKS may provide additional safety benefits that LDW cannot and may more effectively address the number of fatalities and injuries related to lane departure crashes.

1. Updating Lane Departure Warning (LDW)

Lane departure warning is a NHTSA-recommended technology that is currently included in NCAP to mitigate lane departure crashes. LDW systems are used to help prevent crashes that result when a driver unintentionally allows a vehicle to drift out of its lane of travel. These systems often use camera-based sensors to detect lane markers, such as solid lines (including those marked for bike lanes), dashed lines, or raised reflective indicators such as Botts' Dots, ahead of the vehicle.[47] Lane departure alerts are presented to the driver when the system detects that the vehicle is laterally approaching or crossing the lane markings. The alert may be visual, audible, and/or haptic in

---

[37] The study uses the term ''impacts'' but for consistency purposes, NCAP uses the term ''crashes'' in this paragraph.

[38] The Agency notes that the highest number of serious injuries (*i.e.,* MAIS 3–5 injuries) were recorded for lane keeping crashes (21,282 or 0.76 percent of all non-fatal injuries), followed by rear-end crashes (17,918 or 0.64 percent), forward pedestrian crashes (5,973 or 0.21 percent), blind spot crashes (3,476 or 0.12 percent), and backing crashes (454 or 0.02 percent).

[39] Similarly, the study uses the term ''impacts'' but for consistency purposes, NCAP uses the term ''crashes'' in this paragraph.

[40] 49 CFR 571.111. *See* 79 FR 19177 (Apr. 07, 2014).

[41] Wiacek, C., Fikenscher, J., Forkenbrock, G., Mynatt, M., & Smith, P. (2017), Real-world analysis of fatal run-out-of-lane crashes using the National Motor Vehicle Crash Causation Survey to assess lane keeping technologies, *25th International Conference on the Enhanced Safety of Vehicles,* Detroit, Michigan. June 2017, Paper Number 17–0220.

[42] The National Motor Vehicle Crash Causation Survey (NMVVCS) was a nationwide survey of 5,471 crashes involving light passenger vehicles, with a focus on factors related to pre-crash events, which were investigated by the U.S. Department of Transportation and NHTSA over a 2.5-year period from July 3, 2005, to December 31, 2007.

[43] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

[44] When only serious injuries (*i.e.,* MAIS 3–5 injuries) were considered, lane keeping crashes represented the highest number of non-fatal injuries (21,282 or 0.76 percent of all non-fatal injuries), followed by rear-end crashes (17,918 or 0.64 percent), forward pedestrian crashes (5,973 or 0.21 percent), blind spot crashes (3,476 or 0.12 percent), and backing crashes (454 or 0.02 percent).

[45] 73 FR 40016 (July 11, 2008).

[46] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

[47] Note that performance of LDW systems may be adversely affected by precipitation or poor roadway conditions due to construction, unmarked intersections, faded/worn/missing lane markings, markings covered with water, etc.

nature. Visual alerts may show which side of the vehicle is departing the lane, and haptic alerts may be presented as steering wheel or seat vibrations to alert the driver. It is expected that an LDW alert will warn the driver of the unintentional lane shift so the driver can steer the vehicle back into its lane. When a turn signal is activated, the LDW system acknowledges that the lane change is intentional and does not alert the driver.

As NHTSA continues its assessment of LDW systems under NCAP, it plans to use the current NCAP test procedure titled, ''Lane Departure Warning System Confirmation Test and Lane Keeping Support Performance Documentation,'' dated February 2013.[48] This protocol assesses the system's ability to issue an alert in response to a driving situation intended to represent an unintended lane departure and to quantify the test vehicle's position relative to the lane line at the time of the LDW alert. In NCAP's LDW tests, a test vehicle is accelerated from rest to a test speed of 72.4 kph (45 mph) while travelling in a straight line parallel to a single lane line comprised of one of three marking types: Continuous white lines, discontinuous (*i.e.,* dashed) yellow lines, or discontinuous raised pavement markers (*i.e.,* Botts' Dots). The test vehicle is driven such that the centerline of the vehicle is approximately 1.8 m (6 ft.) from the lane edge. This path must be maintained, and the test speed must be achieved, at least 61.0 m (200 ft.) prior to the start gate. Once the driver reaches the start gate, he or she manually inputs sufficient steering to achieve a lane departure with a target lateral velocity of 0.5 m/s (1.6 ft./s) with respect to the lane line. The driver of the vehicle does not activate the turn signal at any point during the test and does not apply any sudden inputs to the accelerator pedal, steering wheel, or brake pedal. The test vehicle is driven at constant speed throughout the maneuver. The test ends when the vehicle crosses at least 0.5 m (1.7 ft.) over the edge of the lane line marking. The scenario is performed for two different departure directions, left and right, and for all three lane marking types, resulting in a total of six test conditions. Five repeated trials runs are performed per test condition.

LDW performance for each test trial is evaluated by examining the proximity of the vehicle with respect to the edge of a lane line at the time of the LDW alert. The LDW alert must not occur when the lateral position of the vehicle, represented by a two-dimensional polygon,[49] is greater than 0.8 m (2.5 ft.) from the inboard edge of the lane line (*i.e.,* the line edge closest to the vehicle when the lane departure maneuver is initiated), and must occur before the lane departure exceeds 0.3 m (1 ft.). To pass the test, the LDW system must satisfy the pass criteria for three of the first five valid individual trials[50] for each combination of departure direction and lane line type (60 percent) and for 20 of the 30 trials overall (66 percent).

NCAP's LDW test conditions represent pre-crash scenarios that correspond to a substantial portion of fatalities and injuries observed in real-world lane departure crashes. In its independent review of the 2011–2015 FARS and GES data sets, Volpe showed that approximately 40 and 30 percent of fatalities in fatal road departure and opposite direction crashes, respectively, occurred when the posted speed was 72.4 kph (45 mph) or less.[51] Similarly, the data indicated 64 and 63 percent of injuries resulted from road departure and opposite direction crashes, respectively, that occurred when the posted speed was 72.4 kph (45 mph) or less.

Although travel speed was unknown or not reported for a high percentage of crashes in FARS and GES,[52] when travel speed was reported, approximately 6 and 9 percent of fatal road departure and opposite direction crashes, respectively, occurred at travel speeds of 72.4 kph (45 mph) or less. Likewise, the data showed 22 and 25 percent of the police-reported non-fatal road departure and opposite direction crashes, respectively, occurred at 72.4 kph (45 mph) or less. Volpe's data review indicates that speeding is prevalent in lane departure relevant pre-crash scenarios, but most road departure- and opposite direction-related fatalities and injuries did not occur on highways. For instance, 79 percent of road departure-related fatal crashes and 89 percent of road departure-related police-reported injuries occurred on roads that were not highways. Similarly, for opposite direction-related crashes, 87 percent of fatalities and 98 percent of injuries did not occur on highways. Because highway driving speeds are on average much higher than non-highway speeds, the Volpe data about a high percentage of crashes occurring at speeds under 72.4 kph (45 mph) appears accurate. The test speed of 72.4 kph (45 mph) appears to address a large portion of the travel speeds where the crashes are occurring.

Furthermore, 62 percent of road departure-related fatalities and 76 percent of road departure-related injuries occurred on straight roads, thereby aligning with NCAP's test procedure. For opposite direction-related crashes, 69 percent of fatalities and 67 percent of police-reported injuries occurred on straight roads.

In its December 2015 notice,[53] NHTSA expressed concern that the safety benefits afforded by LDW technology were being diminished due to false activations. Several studies referenced in that notice had found that drivers were choosing to disable their vehicle's LDW system because it was issuing alerts too frequently. The Agency was also concerned about missed detections resulting from tar lines reflecting sun light or covered with water and other unforeseen anomalies that cause unreliable driver warnings. To address these issues and improve consumer acceptance, NHTSA requested comment in 2015 on whether to revise certain aspects of NCAP's LDW test procedure. Specifically, the Agency solicited comment on whether it is feasible to (1) award NCAP credit to LDW systems that only provide haptic alerts, and (2) develop additional test scenarios to address false activations and missed detections. The Agency also proposed to tighten the inboard lane tolerance for its LDW test procedure from 0.8 to 0.3 m (2.5 to 1.0 ft.). In doing this, an LDW alert could only occur within a window of +0.3 to −0.3 m (+1.0 to −1.0 ft.) with respect to the inside edge of the lane line to pass NCAP's LDW procedure. This proposal effectively increased the space in which a vehicle could operate within a lane before triggering of an LDW alert was permitted. Each of these topics are

---

[48] National Highway Traffic Safety Administration. (2013, February). *Lane departure warning system confirmation test and lane keeping support performance documentation.* See *http://www.regulations.gov,* Docket No. NHTSA–2006–26555–0135.

[49] The two-dimensional polygon is defined by the vehicle's axles in the X-direction (fore-aft), the outer edge of the vehicle's tire in the Y-direction (lateral), and the ground in the Z-direction (vertical).

[50] Trial or test trial is a test among a set of tests conducted under the same test conditions (including test speed) with the same subject vehicle.

[51] Swanson, E., Foderaro, F., Yanagisawa, M., Najm, W.G., & Azeredo, P. (2019, August), *Statistics of light-vehicle pre-crash scenarios based on 2011–2015 national crash data* (Report No. DOT HS 812 745), Washington, DC: National Highway Traffic Safety Administration.

[52] For road departure crashes, 63 and 68 percent of the travel speed data, respectively, is unknown or not reported in FARS and GES. For opposite direction crashes, 65 and 67 percent of the data, respectively, is unknown or not reported in FARS and GES.

[53] 80 FR 78522 (Dec. 16, 2015).

discussed in detail in the sections that follow.

a. Haptic Alerts

With respect to haptic warnings, NHTSA mentioned in its December 2015 notice that these alerts may offer greater consumer acceptance compared to audible alerts, and thus improve the effectiveness of LDW alerts if the driver does not view the alerts as a nuisance and disengage the system. In response to the notice, commenters generally did not support a haptic alert requirement. Some commenters suggested that requiring a specific feedback type would unnecessarily limit the manufacturer's flexibility to issue warnings to the driver, particularly when considering the potential effectiveness of different feedback types and the need to optimize human-machine interface (HMI) designs to address a suite of ADAS. Bosch suggested the Agency should allow all warning options to promote the availability of such systems in a greater number of vehicles, which should ultimately increase consumer awareness and encourage vehicle safety improvements. Advocates stated that the Agency should provide details on the effectiveness of the different types of sensory feedback (visual, auditory, haptic) to justify its decision to encourage one warning type over another. Consumers Union (CU) suggested awarding credit for all LDW feedback types and awarding additional points or credit for haptic alerts to encourage this feedback type in the future. The Automotive Safety Council (ASC) acknowledged that haptic warnings may improve driver acceptance of LDW systems but suggested that false activations must also be reduced to realize improved consumer acceptance and additional safety benefits.

In a large-scale telematics-based study conducted by UMTRI[54] for NHTSA on LDW usage, researchers investigated driver behavior in reaction to alerts. Two types of vehicles were included in the study: Vehicles with audible-only alerts and vehicles where the driver had the option to select either an audible or haptic alert. When the latter was available, the driver selected the haptic warning 90 percent of the time. Otherwise, the LDW system was turned ''off'' 38 percent of the time and thus was not providing alerts. For the system that only provided the audible warning, the LDW was turned ''off'' 71 percent of the time.

Based on the findings from the UMTRI's research, NHTSA concludes that haptic alerts improve driver acceptance of LDW systems. However, the Agency is not certain if an increase in driver acceptance will translate to an improvement in the overall efficacy of the LDW system in reducing crashes. Furthermore, NHTSA does not want to hinder optimization of HMI designs given the increasing number of ADAS technologies available in vehicles today. Therefore, the Agency has decided not to require a specific alert modality for LDW warnings in its related NCAP test procedure at this time, but is requesting comment on whether this decision is appropriate. Although NHTSA has limited data on the effectiveness of the various alert types, it has some concern (similar to the one raised for FCW) that certain LDW systems, such as those that may provide only a visual alert, may be less effective than other alert options in medium or high urgency situations.[55]

b. False Positive Tests

In responding to the 2015 RFC, vehicle manufacturers and suppliers asserted that additional false positive test requirements were not needed even though they acknowledged NHTSA's concern regarding the effect of nuisance alerts on consumer acceptance. Specifically, the Alliance[56] stated that vehicle manufacturers will optimize their systems to minimize false positive activations for consumer acceptance purposes, and thus such tests will not be necessary. Similarly, Honda stated that vehicle manufacturers must already account for false positives when considering marketability and HMI. The manufacturer also indicated that it would be difficult for the Agency to create a valid false positive test procedure that is robust and repeatable. Mobileye, Bosch, and MTS Systems Corporation (MTS) also agreed. In fact, Mobileye explained that it would be hard to reproduce the exact test conditions, especially with respect to weather, over multiple test locations. Also, Bosch stated that the specialized tests required to address the Agency's concern may not be truly representative of all real-world driving situations that the system encounters. MTS suggested that, alternatively, a new test could be added to NCAP's LDW test procedure that would evaluate whether an LDW system can inform the driver that it is no longer able to issue warnings due to poor environmental conditions or other reasons.

Given the concerns expressed regarding repeatability and reproducibility of test conditions, and the fact that the Agency's data do not currently support adoption of a false positive assessment for lane keeping technologies, NHTSA continues to monitor the consumer complaint data related to false positives to help inform an appropriate next step.

With respect to the recommendation from MTS, the Agency recognizes that vehicle manufacturers install LDW telltales on the instrument panel that illuminate to inform drivers when the system is operational. The systems are typically operational when the vehicle's travel speed has reached a preset activation threshold speed and the lane markings and environmental conditions are appropriate. The telltale will disappear if those conditions are not met to inform the driver that the system is no longer operational. In such a state, the system will not provide an alert if the vehicle departs the travel lane. Given this feature, NHTSA has decided a test to inform the driver that the system is no longer issuing warnings is unnecessary at this time.

c. LDW Test Procedure Modifications

Support was varied with respect to NHTSA's proposal in the December 2015 notice to modify the LDW test requirements to reduce the leeway for system activation inside of a lane line from 0.8 to 0.3 m (2.5 to 1.0 ft.). Global Automakers stated that the proposed change was ''unduly prescriptive'' and recommended that the Agency retain the existing lane line tolerance. The organization explained that research showed 90 percent of drivers needed 1.2 s to react to a warning.[57] Citing NCAP's LDW test procedure, which requires a steering input having a target lateral velocity of 0.5 to 0.6 m/s (1.6 to 2 ft./s), the trade association remarked that this requirement equates to a necessary warning distance of 0.6 to 0.72 m (1.9 to 2.4 ft.) to ensure that 90 percent of drivers can react in time to prevent a

---

[54] Flannagan, C., LeBlanc, D., Bogard, S., Nobukawa, K., Narayanaswamy, P., Leslie, A., Kiefer, R., Marchione, M., Beck, C., and Lobes, K. (2016, February), *Large-scale field test of forward collision alert and lane departure warning systems* (Report No. DOT HS 812 247), Washington, DC: National Highway Traffic Safety Administration.

[55] Lerner, N., Robinson, E., Singer, J., Jenness, J., Huey, R., Baldwin, C., & Fitch, G. (2014, September), *Human factors for connected vehicles: Effective warning interface research findings* (Report No. DOT HS 812 068), Washington, DC: National Highway Traffic Safety Administration.

[56] After submitting individual comments on the 2015 RFC, the Alliance and Global Automakers merged to form the Alliance for Automotive Innovation. This document addresses the individual comments from the organizations that were then the Alliance and Global Automakers.

[57] Tanaka, S., Mochida, T., Aga, M., & Tajima, J. (2012, April 16). Benefit Estimation of a Lane Departure Warning System using ASSTREET. *SAE Int. J. Passeng. Cars—Electron. Electr. Syst.* 5(1):133–145, 2012, *https://doi.org/10.4271/2012-01-0289.*

lane departure. Advocates agreed that nuisance notifications are a concern for driver acceptance, but noted that the Agency provided little information about the effectiveness of LDW systems meeting the proposed criteria. Conversely, Delphi, ASC, and MTS commented that some of the more robust systems that are currently available should be able to comply with the narrower specification. However, ASC suggested that the Agency may want to evaluate the impact of the proposed changes before finalizing the requirements to ensure that narrowing the lane line tolerances translates to a reduction in false positive alerts, and thus higher consumer acceptance for LDW systems. Mobileye stated that the tolerance reduction should increase the required accuracy and quality of lane keeping systems. MTS remarked that systems meeting the tighter specification will produce higher driver satisfaction, and, in turn, system use, compared to those that meet only the current requirements. Hyundai Motor Company (Hyundai) also supported the tolerance revision. Consumers Union (CU) agreed with others that the narrowed lateral tolerance should reduce the issuance of false alerts on main roadways but cautioned the Agency that this change may not effectively address false alerts on secondary or curved roads, as vehicles not only tend to approach within one foot of lane lines, but also may cross them. The group suggested that false alert conditions be subject to speed limitations or GPS-based position sensors to avoid ''over activation'' on secondary or curved roads.

Given NHTSA's goal of reducing nuisance notifications to increase consumer acceptance of LDW systems and the statements from several commenters that current LDW systems can meet the proposed reduced test specification, the Agency believes it is reasonable to propose adopting the reduced inboard lane tolerance of 0.3 m (1.0 ft.).

In addition to the comments received pertaining to the lane line tolerance, the Agency also received several suggestions to adopt additional test scenarios for NCAP's LDW test procedure or make alternative procedural modifications. Similar to CU's suggestion above for curved roads, Mobileye suggested that NHTSA add inner and outer curve scenarios that allow a larger tolerance for the inner lane boundary than that permitted on a straight road. The company further recommended that the Agency add road edge detection scenarios, including curbs and non-structural delimiters such as gravel or dirt, to reflect real-world conditions and crash scenarios more accurately. Similarly, Bosch suggested that NHTSA consider introducing road edge detection requirements in addition to lane markings since not all roads have lane markings. Additionally, Mobileye suggested that NHTSA alter the Botts' Dots detail #4 (Botts dots are round, raised markers that mark lanes) to align with California detail #13, which is more common, and modify the test procedure to include Botts' Dots on both sides of the lane or Botts' Dots and a solid line, as these are the most frequently observed marking pairings.

The Agency appreciates suggestions from commenters and agrees that there is merit to considering other procedural modifications for NCAP's lane departure test procedure(s). As will be discussed in the next section, the Agency is planning to conduct a feasibility study to determine whether curved roads can be considered for inclusion in NCAP test procedures to evaluate LKS systems objectively. NHTSA also plans to perform research to assess how lane keeping system performance on a test track compares to real-world data for different combinations of curve radius, vehicle speed, and departure timing. Additionally, the Agency recognizes that the European NCAP program (Euro NCAP) has adopted a road edge detection test that is conducted in a similar manner to their ''lane keep assist'' tests (described in the next section), but the road edge detection test does not use lane markings. Although NHTSA believes the number of vehicles equipped with an ability to recognize and respond to road edges not defined with a lane line is presently low, it has identified roadways where this capability could prevent crashes. Therefore, the Agency is requesting comment on whether a road edge detection test for either LDW and/or LKS is appropriate for inclusion in NCAP. In consideration of the lane markings currently assessed, the Agency proposes to remove the Botts' Dots test scenario from the current LDW test, as the lane marking type is being removed from use in California.[58] At this time, the Agency believes the traditional dashed and solid lane marking tests would be sufficient.

Although NHTSA has tentatively decided not to adopt additional false activation requirements for this NCAP upgrade, the Agency is still concerned about the low effectiveness of LDW and its lack of consumer acceptance stemming from nuisance alerts and missed detections.

When NHTSA decided to include ADAS in the NCAP program in 2008,[59] LDW was selected because it met NCAP's four established criteria: (1) The technology addressed a major crash problem; (2) the system design of LDW had the potential to mitigate the crash problem; (3) safety benefits were projected, and (4) test procedures and evaluation criteria were available to ensure an acceptable performance level. At the time, the Agency estimated that existing LDW systems were 6 to 11 percent effective in preventing lane departure crashes. Although the system's effectiveness was relatively low, NHTSA cited the large number of road departure and opposite direction crashes occurring on the nation's roadways as well as the resulting AIS 3+ injuries, as reasons to include LDW in NCAP. Several recent studies have provided varying results with respect to LDW effectiveness.

In a 2017 study,[60] the Insurance Institute for Highway Safety (IIHS) concluded that LDW systems were effective in reducing three types of passenger car crashes (single-vehicle, side-swipes, and head-on) by 11 percent, which is the same rate NHTSA originally estimated. Importantly, IIHS also concluded that LDW systems reduce injuries in those same types of crashes by 21 percent. In its recent study of real-world effectiveness of crash avoidance technologies in GM vehicles,[61] UMTRI found that LDW systems showed a 3 percent reduction for applicable crashes that was determined to be not statistically significant. Conversely, the active safety technology, LKS (which also included lane departure warning capability), showed an estimated 30 percent reduction in applicable crashes.

Other studies that examined driver deactivation rates also suggest that LDW effectiveness may be lower than originally estimated. In a survey of Honda vehicles brought into Honda

---

[58] Winslow, J. (2017, May 19), Botts' Dots, after a half-century, will disappear from freeways, highways, *The Orange County Register, https://www.ocregister.com/2017/05/19/botts-dots-after-a-half-century-will-disappear-from-freeways-highways/.*

[59] 73 FR 40033 (July 11, 2008).

[60] Insurance Institute for Highway Safety (2017, August 23), *Lane departure warning, blind spot detection help drivers avoid trouble, https://www.iihs.org/news/detail/stay-within-the-lines-lane-departure-warning-blind-spot-detection-help-drivers-avoid-trouble.*

[61] Flannagan, C. and Leslie, A., Crash Avoidance Technology Evaluation Using Real-World Crashes, DTHN2216R00075 Vehicle Electronics Systems Safety IDIQ, The University of Michigan Transportation Research Institute Final Report, March 22, 2018.

dealerships for service,[62] IIHS researchers found that for 184 models equipped with an LDW system, only a third of the vehicles had the system activated. Furthermore, in its telematics-based study on LDW usage,[63] UMTRI found that, overall, drivers turned off LDW systems 50 percent of the time. However, in Consumer Reports' August 2019 survey of more than 57,000 CR subscribers, the organization found that 73 percent of vehicle owners reported that they were satisfied with LDW technology. In fact, 33 percent said that the system had helped them avoid a crash, and 65 percent said that they trusted the system to work every time.[64]

In light of these findings, the Agency believes that, in addition to LDW, there is merit to adopting an active lane keeping system, such as lane keeping support (LKS), in NCAP. As an enhanced active system, LKS offers the steering and/or braking capability necessary to guide a vehicle back into its lane without consumer action and should therefore further enhance safety benefits beyond those that can be realized by LDW. A detailed discussion pertaining to LKS technology is provided in the following section.

2. Adding Lane Keeping Support (LKS)

LDW systems warn a driver that their vehicle is unintentionally drifting out of their travel lane, while lane keeping support (LKS) systems are designed to actively guide a drifting vehicle back into the travel lane by gently counter steering or applying differential braking. During an unintended lane departure where the driver is not using the turn signal, LKS systems help to prevent: ''Sideswiping'' where a vehicle strikes another vehicle in an adjacent lane that is travelling in the same direction; opposite direction crashes where a vehicle crosses the centerline and strikes another vehicle travelling in the opposite direction; and road departure crashes where a vehicle runs off the road resulting in a rollover crash or an impact with a tree or other object. LKS systems may also help to prevent unintended lane departures into designated bicycle lanes in situations where the system's speed threshold is met.

LKS systems typically utilize the same camera(s) used by LDW systems to monitor the vehicle's position within the lane, and determine whether a vehicle is about to drift out of its lane of travel unintentionally. In such instances, LKS automatically intervenes by: Braking one or more of the vehicle's wheels; steering; or using a combination of braking and steering so that the vehicle returns to its intended lane of travel. LKS is one of two active lane keeping technologies mentioned in the Agency's March 2019 report,[65] with the other being lane centering assist (LCA). LKS assists the driver by providing short-duration steering and/or braking inputs when a lane departure is imminent or underway, whereas LCA provides continuous assistance to the driver to keep their vehicle centered within the lane.

As discussed in the previous section, UMTRI evaluated the real-world effectiveness of ADAS technologies, including LDW and LKS.[66] The results of the LKS study (which also included lane departure warning functionality) showed an estimated 30 percent reduction in applicable crashes. Additionally, in its August 2019 survey, 74 percent of vehicle owners reported that they were satisfied with LKS technology, and 35 percent said that it had helped them avoid a crash. Sixty-five percent of owners said that they trusted the system to work every time.[67]

In its December 2015 notice, NHTSA did not propose including LKS technology as part of the update to NCAP. However, many commenters recommended that the Agency consider including the technology. For instance, Bosch and Mobileye stated that LKS systems have the potential to prevent or mitigate a greater number of collisions involving injuries and fatalities than LDW systems. The ASC and Delphi recommended that the Agency adopt LKS in lieu of LDW, with the ASC adding that Euro NCAP has included LKS in its Lane Support Systems test protocol since 2016.[68] [69] The ASC, Bosch, and Continental noted the maturity of LKS technology and stated that such systems were already widely available in vehicles produced at the time. Other proponents of adopting LKS technology in NCAP include the National Safety Council (NSC), ZF TRW, and Honda. ZF TRW recommended that the Agency adopt both active lane keeping (termed LKS in this notice) and lane centering systems (termed LCA in this notice) due to the high frequency of fatal road departure crashes. Honda also supports the active safety benefits of LKS and the system's potential to help prevent crashes. NSC suggested that the Agency include LKS, as it would complement LDW, which is already in the program, similar to the way the warning component of FCW complements the active safety functionality of AEB.

As mentioned previously, the Agency agrees with commenters that there is merit to adopting LKS technology in NCAP. However, NHTSA believes an LDW system integrated with LKS may be a better approach for the Agency to consider rather than replacing LDW with LKS. NHTSA believes, as NSC commented, that an integrated approach (inclusive of passive and active safety capabilities for lane support systems) would be similar to what the Agency is proposing for frontal collision avoidance systems, FCW and AEB, later in this notice.

NHTSA is considering the adoption of certain test methods (*e.g.,* those for ''lane keep assist'') contained within the Euro NCAP Test Protocol—Lane Support Systems (LSS) [70] to assess technology design differences for LKS. Since the test speeds and road configurations specified in this protocol are similar to those stipulated in the Agency's LDW test procedure, the Agency believes Euro NCAP's test protocol will sufficiently address the lane keeping crash typology previously detailed for LDW.

Euro NCAP's LSS test procedure includes a series of ''lane keep assist''

---

[62] Insurance Institute for Highway Safety (2016, January 28), Most Honda owners turn off lane departure warning, *Status Report, Vol. 51, No. 1,* page 6.

[63] Flannagan, C., LeBlanc, D., Bogard, S., Nobukawa, K., Narayanaswamy, P., Leslie, A., Kiefer, R., Marchione, M., Beck, C., and Lobes, K. (2016, February), *Large-scale field test of forward collision alert and lane departure warning systems* (Report No. DOT HS 812 247), Washington, DC: National Highway Traffic Safety Administration.

[64] Consumer Reports (2019, August 5), *Guide to lane departure warning & lane keeping assist: Explaining how these systems can keep drivers on the right track, https://www.consumerreports.org/car-safety/lane-departure-warning-lane-keeping-assist-guide/.*

[65] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

[66] Carol Flannagan, Andrew Leslie, Crash Avoidance Technology Evaluation Using Real-World Crashes, DTHN2216R00075 Vehicle Electronics Systems Safety IDIQ, The University of Michigan Transportation Research Institute Final Report, March 22, 2018.

[67] Consumer Reports. (2019, August 5), *Guide to lane departure warning & lane keeping assist: Explaining how these systems can keep drivers on the right track, https://www.consumerreports.org/car-safety/lane-departure-warning-lane-keeping-assist-guide/.*

[68] The ASC argued that data from the Highway Loss Data Institute (HLDI) have shown no statistically significant difference in collision claim frequencies for vehicles equipped with LDW compared to those without, and questioned whether LDW systems are effective in reducing crashes or fatalities.

[69] European New Car Assessment Programme (Euro NCAP) (2015, November), *Test Protocol—Lane Support Systems, Version 1.0.*

[70] European New Car Assessment Programme (Euro NCAP) (2019, July), *Test Protocol—Lane Support Systems, Version 3.0.2.* See section 7.2.5, Lane Keep Assist tests.

trials that are performed with iteratively increasing lateral velocities towards the desired lane line. Each ''lane keep assist'' trial begins with the subject vehicle (SV) (*i.e.,* the vehicle being evaluated) being driven at 72 kph (44.7 mph) down a straight lane delineated by a single solid white or dashed white line. Initially, the SV path is parallel to the lane line, with an offset from the lane line that depends on the lateral velocity used later in the maneuver. Then, after a short period of steady-state driving, the direction of travel of the SV is headed towards the lane line using a path defined by a 1,200 m (3,937.0 ft.) radius curve. The lateral velocity of the SV's approach towards the lane line (from both the left and right directions) is increased from 0.2 to 0.5 m/s (0.7 to 1.6 ft./s) in 0.1 m/s (0.3 ft./s) increments until acceptable LKS performance is no longer realized. Acceptable LKS performance occurs when the SV does not cross the inboard leading edge of the lane line by more than 0.3 m (1.0 ft.).

NHTSA conducted a limited assessment of five model year 2017 vehicles equipped with LKS systems. The Agency used a robotic steering controller to maximize the repeatability and minimize variability associated with manual steering inputs. For this study, NHTSA also used a slightly modified and older version of Euro NCAP's LSS test procedure from what was discussed above. Specifically, the lateral velocity of the SV's approach towards the lane line was increased from 0.1 m/s to 1.0 m/s in 0.1 m/s increments (0.3 ft./s to 3.3 ft./s in 0.3 ft./s increments) to assess how LKS systems would perform at higher velocities. In addition, LKS performance was considered acceptable (when compared to Euro NCAP's assessment criteria at the time of NHTSA's testing) for instances where the SV did not cross the inboard leading edge of the lane line by more than 0.4 m (1.3 ft.).[71]

A preliminary analysis of the five tested vehicles identified performance differences between the vehicles depending on the lateral velocity used during the test. Some vehicles only engaged a steering response at lower lateral velocities and others continued to provide a steering input as the lateral velocity was increased.[72] The maximum excursion over the lane marking after an LKS activation was also found to be inconsistent, particularly as lateral velocity increased. These preliminary findings suggested that there are performance differences in how vehicle manufacturers are designing their systems for a given set of operating conditions.

The results from these tests, as measured by the maximum excursions over the lane marking, were compared to the measured shoulder width of roads where fatal road departure crashes occurred. The analysis identified roadways where the shoulder width of the roadway was less than the 0.4 m (1.3 ft.) maximum excursion limit (*e.g.,* certain rural roadways) used in the Agency's testing. It was observed that only vehicles displaying robust LKS performance, including at higher lateral velocities, would likely prevent the vehicle from departing the travel lane on these roadways. However, most of the roadway departure crashes were on roads where the shoulder width exceeded 0.4 m (1.3 ft.). On these roadways, assuming the LKS was engaged, the lane departure could have been avoided. However, some vehicles did not perform well, with several exhibiting no system intervention, and others exceeding the maximum excursion limit as the lateral velocity was increased. To supplement these initial findings, additional LKS testing has since been conducted and is undergoing analysis.

Since the analysis showed that most fatal crashes identified in the study were on roadways having shoulder widths that exceeded the current Euro NCAP test excursion limit of 0.3 m (1.0 ft.), NHTSA believes that adopting the Euro NCAP criterion may provide significant safety benefits, but is requesting comment on whether an even smaller excursion limit may be more appropriate. Furthermore, as the study also identified fatal crashes where lane markers were not present on the side of the roadway where a departure occurred (such that LKS would not provide any benefit unless it had the capability to identify the edge of the roadway), the Agency is also requesting comment (as mentioned previously) on adding Euro NCAP's road edge detection test to NCAP so that it may begin to address crashes that occur where lane markings may not be present.

Based on the findings from NHTSA's LKS testing, which showed differences in LKS performance at greater lateral velocities, the Agency is concerned about LKS performance at higher travel speeds when the vehicle first transitions from a straight to a curved road where lateral velocity may inherently be high. In its independent analysis of the 2011–2015 FARS data set, Volpe found that 29 percent of fatal road departure crashes and 26 percent of fatal opposite direction crashes occurred at known travel speeds exceeding 72.4 kph (45 mph). The analysis also showed that 55 percent of fatal road departure crashes and 67 percent of opposite direction crashes occurred on roads with posted speeds exceeding 72.4 kph (45 mph).[73] [74] Furthermore, the study revealed that speeding was a factor in 31 percent and 13 percent of fatal road departure and opposite direction crashes, respectively.[75] Since NHTSA does not currently have data to show that LKS system performance at Euro NCAP's current test speed of 72 kph (44.7 mph) would be indicative of system performance when tested at higher speeds, NHTSA is requesting comment on whether it would be beneficial to incorporate additional, higher test speeds to assess the performance of lane keeping systems in NCAP.

To date, NHTSA has only performed test track LKS evaluations using the straight road test configuration specified in the Euro NCAP test procedure. However, the Agency recognizes that a significant portion of road departure and opposite direction crashes resulting in fatalities and injuries occur on curved roads. A review of Volpe's 2011–2015 data set[76] showed that for road departure crashes, 37 percent of fatalities and 20 percent of injuries occurred on curved roads. For opposite direction crashes, 30 percent of fatalities and 31 percent of injuries occurred on curved roads. NHTSA is not certain how LKS performance observed during straight road trials performed on a test

---

[71] At the time of testing, an older version of Euro NCAP's LSS test procedure was available. This version stipulated a lane keep assist assessment criterion of 0.4 m (1.3 ft.) for the maximum excursion over the inside edge of the lane marking. European New Car Assessment Programme (Euro NCAP). See *Assessment Protocol—Safety Assist, Version 7.0* (2015, November).

[72] Wiacek, C., Forkenbrock, G., Mynatt, M., & Shain, K. (2019), Applying lane keeping support test track performance to real-world crash data, *26th Enhanced Safety of Vehicles Conference,* Eindhoven, Netherlands. June 2019, Paper Number 19–0208.

[73] Swanson, E., Foderaro, F., Yanagisawa, M., Najm, W.G., & Azeredo, P. (2019, August), *Statistics of light-vehicle pre-crash scenarios based on 2011–2015 national crash data* (Report No. DOT HS 812 745), Washington, DC: National Highway Traffic Safety Administration.

[74] For data where the travel speed was known, 63 and 65 percent of the data is unknown or not reported in FARS for road departure and opposite direction crashes, respectively. For road departure and opposite direction crashes, respectively, 3 and 1 percent of the posted speed data is unknown or not reported in FARS.

[75] Swanson, E., Foderaro, F., Yanagisawa, M., Najm, W.G., & Azeredo, P. (2019, August), *Statistics of light-vehicle pre-crash scenarios based on 2011–2015 national crash data* (Report No. DOT HS 812 745), Washington, DC: National Highway Traffic Safety Administration.

[76] Ibid.

track would correlate to real-world system performance on curved roads. However, NHTSA believes, based on on-road performance testing experience of newer model year vehicles, that some current system designs include provisions to address lane departures on curved roads. The Agency observed that some LKS systems engage by providing limited operation throughout a curve—which may offer little (if any) safety benefits. However, other more sophisticated LKS systems maintain engagement longer and offer more directional authority throughout a curve. These systems may provide additional safety gains because the driver has more time to re-engage (*i.e.,* restore effective manual control of the vehicle).

In NHTSA's study of the 2005 through 2007 fatal crashes[77] from NMVCCS, crashes that occurred on curved roads[78] where the driver departed the travel lane were analyzed. The analysis showed that, unlike for straight roads where LKS systems may provide smaller corrective steering inputs to prevent the vehicle from departing the lane, LKS systems would have to provide sustained lateral correction (*i.e.,* corrective steering) on a curved road to prevent the vehicle from departing the lane.

Furthermore, in fleet testing of select model year 2012 through 2018 vehicles equipped with LDW and LKS (referenced in the report as LKA), Transport Canada[79] found variability in test results and generally unpredictable system behavior on curved roads. Thus, Transport Canada stated that it was not possible to gather enough data to assess the potential safety benefits associated with the technology.

To address these unknowns and further understand the potential effectiveness of LKS systems in the real world, the Agency is considering additional research to study whether testing on curved roads should be considered for objective evaluation of LKS systems, and collect a combination of test track and real-world data to quantify how LKS systems will operate when exposed to different combinations of curve radius, vehicle speed, and departure timing (*e.g.,* at curve onset or midway through the curve).

With respect to LDW and LKS, NHTSA is seeking comment on the following:

(1) Should the Agency award credit to vehicles equipped with LDW systems that provide a passing alert, regardless of the alert type? Why or why not? Are there any LDW alert modalities, such as visual-only warnings, that the Agency should not consider acceptable when determining whether a vehicle meets NCAP's performance test criteria? If so, why? Should the Agency consider only certain alert modalities (such as haptic warnings) because they are more effective at re-engaging the driver and/or have higher consumer acceptance? If so, which one(s) and why?

(2) If NHTSA were to adopt the lane keeping assist test methods from the Euro NCAP LSS protocol for the Agency's LKS test procedure, should the LDW test procedure be removed from its NCAP program entirely and an LDW requirement be integrated into the LKS test procedure instead? Why or why not? For systems that have both LDW and LKS capabilities, the Agency would simply turn off LKS to conduct the LDW test if both systems are to be assessed separately. What tolerances would be appropriate for each test, and why?

(3) LKS system designs provide steering and/or braking to address lane departures (*e.g.,* when a driver is distracted).[80] To help re-engage a driver, should the Agency specify that an LDW alert must be provided when the LKS is activated? Why or why not?

(4) Do commenters agree that the Agency should remove the Botts' Dots test scenario from the current LDW test procedure since this lane marking type is being removed from use in California?[81] If not, why?

(5) Is the Euro NCAP maximum excursion limit of 0.3 m (1.0 ft.) over the lane marking (as defined with respect to the inside edge of the lane line) for LKS technology acceptable, or should the limit be reduced to account for crashes occurring on roads with limited shoulder width? If the tolerance should be reduced, what tolerance would be appropriate and why? Should this tolerance be adopted for LDW in addition to LKS? Why or why not?

(6) In its LSS Protocol, Euro NCAP specifies use of a 1,200 m (3,937.0 ft.) curve and a series of increasing lateral offsets to establish the desired lateral velocity of the SV towards the lane line it must respond to. Preliminary NHTSA tests have indicated that use of a 200 m (656.2 ft.) curve radius provides a clearer indication of when an LKS intervention occurs when compared to the baseline tests performed without LKS, a process specified by the Euro NCAP LSS protocol. This is because the small curve radius allows the desired SV lateral velocity to be more quickly established; requires less initial lateral offset within the travel lane; and allows for a longer period of steady state lateral velocity to be realized before an LKS intervention occurs. Is use of a 200 m (656.2 ft.) curve radius, rather than 1,200 m (3,937.0 ft.), acceptable for inclusion in a NHTSA LKS test procedure? Why or why not?

(7) Euro NCAP's LSS protocol specifies a single line lane to evaluate system performance. However, since certain LKS systems may require two lane lines before they can be enabled, should the Agency use a single line or two lines lane in its test procedure? Why?

(8) Should NHTSA consider adding Euro NCAP's road edge detection test to its NCAP program to begin addressing crashes where lane markings may not be present? If not, why? If so, should the test be added for LDW, LKS, or both technologies?

(9) The LKS and ''Road Edge'' recovery tests defined in the Euro NCAP LSS protocol specify that a range of lateral velocities from 0.2 to 0.5 m/s (0.7 to 1.6 ft./s) be used to assess system performance, and that this range is representative of the lateral velocities associated with unintended lane departures (*i.e.,* not an intended lane change). However, in the same protocol, Euro NCAP also specifies a range of lateral velocities from 0.3 to 0.6 m/s (1.0 to 2.0 ft./s) be used to represent unintended lane departures during ''Emergency Lane Keeping—Oncoming vehicle'' and ''Emergency Lane Keeping—Overtaking vehicle'' tests. To encourage the most robust LKS system performance, should NHTSA consider a combination of the two Euro NCAP unintended departure ranges, lateral velocities from 0.2 to 0.6 m/s (0.7 to 2.0 ft./s), for inclusion in the Agency's LKS evaluation? Why or why not?

(10) As discussed above, the Agency is concerned about LKS performance on roads that are curved. As such, can the

---

[77] Wiacek, C., Fikenscher, J., Forkenbrock, G., Mynatt, M., & Smith, P. (2017), Real-world analysis of fatal run-out-of-lane crashes using the National Motor Vehicle Crash Causation Survey to assess lane keeping technologies, *25th International Technical Conference on the Enhanced Safety of Vehicles,* Detroit, Michigan. June 2017, Paper Number 17–0220.

[78] It should be noted that the paper identified crashes where lane markings were not present on the side of the departure.

[79] Meloche, E., Charlebois, D., Anctil, B., Pierre, G., & Saleh, A. (2019), ADAS testing in Canada: Could partial automation make our roads safer? *26th International Technical Conference on the Enhanced Safety of Vehicles,* Eindhoven, Netherlands, June 2019, Paper Number 19–0339.

[80] Cicchino, J.B. & Zuby, D.S. (2016, October), Prevalence of driver physical factors leading to unintentional lane departure crashes, *Traffic Injury Prevention,* 18(5), 481–487, *https://doi.org/10.1080/15389588.2016.1247446.*

[81] Winslow, J. (2017, May 19), Botts' Dots, after a half-century, will disappear from freeways, highways, *The Orange County Register, https://www.ocregister.com/2017/05/19/botts-dots-after-a-half-century-will-disappear-from-freeways-highways/.*

Agency correlate better LKS system performance at higher lateral velocities on straight roads with better curved road performance? Why or why not? Furthermore, can the Agency assume that a vehicle that does not exceed the maximum excursion limits at higher lateral velocities on straight roads will have superior curved road performance compared to a vehicle that only meets the excursion limits at lower lateral velocities on straight roads? Why or why not? And lastly, can the Agency assume the steering intervention while the vehicle is negotiating a curve is sustained long enough for a driver to re-engage? If not, why?

(11) The Agency would like to be assured that when a vehicle is redirected after an LKS system intervenes to prevent a lane departure when tested on one side, if it approaches the lane marker on the side not tested, the LKS will again engage to prevent a secondary lane departure by not exceeding the same maximum excursion limit established for the first side. To prevent potential secondary lane departures, should the Agency consider modifying the Euro NCAP ''lane keep assist'' evaluation criteria to be consistent with language developed for NHTSA's BSI test procedure to prevent this issue? Why or why not? NHTSA's test procedure states the SV BSI intervention shall not cause the SV to travel 0.3 m (1 ft.) or more beyond the inboard edge of the lane line separating the SV travel lane from the lane adjacent and to the right of it within the validity period. To assess whether this occurs, a second lane line is required (only one line is specified in the Euro NCAP LSS protocol for LKS testing). Does the introduction of a second lane line have the potential to confound LKS testing? Why or why not?

(12) Since most fatal road departure and opposite direction crashes occur at higher posted and known travel speeds, should the LKS test speed be increased, or does the current test speed adequately indicate performance at higher speeds, especially on straight roads? Why or why not?

(13) The Agency recognizes that the LKS test procedure currently contains many test conditions (*i.e.,* line type and departure direction). Is it necessary for the Agency to perform all test conditions to address the safety problem adequately, or could NCAP test only certain conditions to minimize test burden? For instance, should the Agency consider incorporating the test conditions for only one departure direction if the vehicle manufacturer provides test data to assure comparable system performance for the other direction? Or, should the Agency consider adopting only the most challenging test conditions? If so, which conditions are most appropriate? For instance, do the dashed line test conditions provide a greater challenge to vehicles than the solid line test conditions?

(14) What is the appropriate number of test trials to adopt for each LKS test condition, and why? Also, what is an appropriate pass rate for the LKS tests, and why?

(15) Are there any aspects of NCAP's current LDW or proposed LKS test procedure that need further refinement or clarification? Is so, what additional refinements or clarifications are necessary?

B. Blind Spot Detection Technologies

NHTSA's 2019 target population study showed that blind spot detection technologies such as blind spot warning (BSW), blind spot intervention (BSI), and lane change/merge warning (LCM) (which is essentially a BSI warning system), can help prevent or mitigate five pre-crash lane change/merge scenarios. These pre-crash movements represented, on average, 503,070 crashes annually, or 8.7 percent of all crashes that occurred on U.S. roadways, and resulted in 542 fatalities and 188,304 MAIS 1–5 injuries, as shown in Table A–3. This equated to 1.6 percent of all fatalities and 6.7 percent of all injuries recorded.[82]

Currently, NCAP does not include any ADAS technology that is designed to address blind spot pre-crash scenarios. NHTSA requested comment on the inclusion of BSW as part of its upgrade to the program in its 2015 notice. Although the Agency did not recommend BSI for inclusion at that time, the Agency is proposing that both BSW and BSI technologies be adopted as part of this program update.

Although the target population for blind spot detection technology may not be as large as the populations for AEB or lane keeping technologies, NHTSA believes there is merit to including blind spot technologies in NCAP. Consumer Reports found in its 2019 survey that 82 percent of vehicle owners were satisfied with BSW technology, 60 percent said that it had helped them avoid a crash, and 68 percent stated that they trusted the system to work every time.[83] The Agency believes the technology's high consumer acceptance rate, in addition to its potential safety benefits discussed later in this section, supports its inclusion in the Agency's signature consumer information program.

1. Adding Blind Spot Warning (BSW)

A BSW system is a warning-based driver assistance system designed to help the driver recognize that another vehicle is approaching, or being operated within, the blind spot of their vehicle in an adjacent lane. In these driving situations, and for all production BSW systems known to NHTSA, the BSW alert is automatically presented to the driver, and is most relevant to a driver who is contemplating, or who has just initiated, a lane change. Depending on the system design, additional BSW features may be activated if the system is presenting an alert and then the driver operates their turn signal indicator.

BSW systems use camera-, radar-, or ultrasonic-based sensors, or some combination thereof, as their means of detection. These sensors are typically located on the sides and/or rear of a vehicle. BSW alerts may be auditory, visual (most common), or haptic. Visual alerts are usually presented in the side outboard mirror glass, inside edge of the mirror housing, or at the base of the front a-pillars inside the vehicle. When another vehicle enters, or approaches, the driver's blind spot while operating in an adjacent lane, the BSW visual alert will typically be continuously illuminated. However, if the driver engages the turn signal in the direction of the adjacent vehicle while the visual alert is present, the visual alert may transition to a flashing state and/or be supplemented with an additional auditory or haptic alert (*e.g.,* beeping or vibration of the steering wheel or seat, respectively).

NHTSA requested comment on a draft research blind spot detection (BSD) test procedure (referred to in this notice as BSW) published on November 21, 2019[84] to assess systems' performance and capabilities in blind spot related pre-crash scenarios. This test procedure exercises the BSW system in two different scenarios on the test track: the Straight Lane Converge and Diverge Test, and the Straight Lane Pass-by Test. These two tests assess whether the BSW system displays a warning when other vehicles, referred to as principal other

---

[82] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

[83] Monticello, M. (2017, June 29), *The positive impact of advanced safety systems for cars: The latest car-safety technologies have the potential to significantly reduce crashes,* Consumer Reports, *https://www.consumerreports.org/car-safety/positive-impact-of-advanced-safety-systems-for-cars/.*

[84] 84 FR 64405 (Nov. 21, 2019).

vehicles (POVs), are within the driver's blind spot. The test occurs without activation of the tested vehicle's, referred to as the subject vehicle (SV), turn signal. Neither the SV nor POV turn signals are to be activated at any point during any test trial. A short description of each test scenario and the requirements for a passing result is provided below:

- Straight Lane Converge and Diverge Test—The POV and SV are driven parallel to each other at a constant speed of 72.4 kph (45 mph) such that the front-most part of the POV is 1.0 m (3.3 ft.) ahead of the rear-most part of the SV in the outbound lanes of a three-lane straight road. After 2.5 s of steady-state driving, the POV enters (*i.e.,* converges into) the SV's blind zone[85] by making a single lane change into the lane immediately adjacent to the SV using a lateral velocity of 0.25 to 0.75 m/s (0.8 to 2.5 ft./s). The period of steady-state driving resumes for at least another 2.5 s and then the POV exits (*i.e.,* diverges from) the SV's blind zone by returning to its original travel lane using a lateral velocity of 0.25 to 0.75 m/s (0.8 to 2.5 ft./s). This test is repeated for a POV approach from both the left and the right side of the SV.

—To pass a test trial: during the converge lane change, the BSW alert must be presented by a time no later than 300 ms after any part of the POV enters the SV blind zone and must remain on while any part of the POV resides within the SV blind zone; and during the diverge lane change, the BSW alert may remain active only when the lateral distance between the SV and POV is greater than 3 m (9.8 ft.) but less than or equal to 6 m (19.7 ft.). The BSW alert shall not be active once the lateral distance between the SV and POV exceeds 6 m (19.7 ft.).

- Straight Lane Pass-by Test—The POV approaches and then passes the SV while being driven in an adjacent lane. For each trial, the SV is traveling at a constant speed of 72.4 kph (45 mph) whereas the POV is traveling at one of four constant speeds—80.5, 88.5, 96.6, or 104.6 kph (50, 55, 60, or 65 mph). The lateral distance between the two vehicles, defined as the closest lateral distance between adjacent sides of the polygons used to represent each vehicle, shall nominally be 1.5 m (4.9 ft.) for the duration of the trial. This test is repeated for a POV approach towards the SV from an adjacent lane to the left and to the right of the SV.

—To pass a test trial, the BSW alert must be presented by a time no later than 300 ms after the front-most part of the POV enters the SV blind zone and remain on while the front-most part of the POV resides behind the front-most part of the SV blind zone. The BSW alert shall not be active once the longitudinal distance between the front-most part of the SV and the rear-most part of the POV exceeds the BSW termination distance specified for each POV speed.

For the BSW tests, each scenario is tested using seven repeated trials for each combination of approach direction (left and right side of the SV) and test speed. This translates to a total of 14 tests overall for the Straight Lane Converge and Diverge Test and 56 tests overall for the Straight Lane Pass-by Test. NCAP is proposing that to pass the NCAP system performance requirements, the SV must pass at least five out of seven trials conducted for each approach direction and test speed.

The proposed BSW tests represent pre-crash scenarios that correspond to a substantial portion of fatalities and injuries observed in real-world lane change crashes. A review of Volpe's 2011–2015 data set showed that approximately 28 percent of fatalities and 57 percent of injuries in lane change crashes occurred on roads with posted speeds of 72.4 kph (45 mph) or lower.[86] For crashes where the travel speed was reported in FARS and GES, approximately 14 percent of fatalities and 24 percent of injuries occurred at speeds of 72.4 kph (45 mph) or lower.[87] Furthermore, Volpe found that speeding was a factor in only 18 percent of the fatal lane change crashes and 3 percent of lane change crashes that resulted in injuries. This suggests that posted speed corresponds well to travel speed in most lane change crashes.[88] [89]

As noted earlier, market research conducted by Consumer Reports (CR) indicated that BSW systems are desirable in consumer interest surveys of various ADAS technologies. In fact, CR found not only that an overwhelming majority of vehicle owners were satisfied with BSW technology, but also that 60 percent of them believed BSW technology had helped them avoid a crash. However, in its study to evaluate the real-world effectiveness of ADAS technologies in model year 2013–2017 General Motors' (GM) vehicles, UMTRI found that GM's Side Blind Zone Alert produced a non-significant 3 percent reduction in lane change crashes. When the Side Blind Zone Alert technology was combined with an earlier generation technology, GM's Lane Change Alert, the corresponding effectiveness increased to 26 percent.[90] UMTRI attributed this increase to substantially longer vehicle detection ranges for the Lane Change Alert with Side Blind Zone Alert system compared to GM's earlier generation Side Blind Zone Alert system.[91] An Agency study of three BSW-equipped vehicles also showed that that currently available BSW systems may likely exhibit differences in detection capabilities and operating conditions such that their effectiveness estimates could vary significantly.[92] For instance, one vehicle's system may simply augment a driver's visual awareness whereas another may effectively prevent crashes by warning of higher speed lane change events. In its response to NCAP's December 2015 notice, Bosch provided similar insight. The company stated that some BSW systems may only provide benefit for shorter detection distances, such as 7 m (23.0 ft.) rearward, whereas other systems may provide detection for distances up to 70 m (229.7 ft.) rearward, which would help the driver avoid collisions with vehicles approaching from the rear in adjacent lanes at high speeds. The Agency plans to study these performance differences in its testing.

---

[85] SV blind zones are defined by two rectangular regions that extend to the side and rear of the SV. Each rectangle is 8.2 ft. (2.5 m) wide and is represented by lines parallel to the longitudinal centerline of the vehicle but offset 1.6 ft. (0.5 m) from the outermost edge of the SV's body excluding the side view mirror(s). The rearward projection begins at the rearmost part of the SV side mirror housing and ends at a rearward boundary that is dependent on the relative speed between the SV and POV. The blind zone is fully described in the test procedure.

[86] The posted speed limit was either not reported or was unknown in 2 percent of fatal lane change crashes and 18 percent of lane change crashes that resulted in injuries.

[87] The travel speed was either not reported or was unknown in 60 percent of fatal lane change crashes and 68 percent of lane change crashes that resulted in injuries.

[88] Swanson, E., Foderaro, F., Yanagisawa, M., Najm, W.G., & Azeredo, P. (2019, August), *Statistics of light-vehicle pre-crash scenarios based on 2011–2015 national crash data* (Report No. DOT HS 812 745), Washington, DC: National Highway Traffic Safety Administration.

[89] It was unknown or not reported whether speeding was a factor in 3 percent of fatal lane change crashes and 7 percent of lane change crashes that resulted in injuries.

[90] Leslie, A.J., Kiefer, R.J., Meitzner, M.R., & Flannagan, C. A. (2019), *Analysis of the field effectiveness of General Motors production active safety and advanced headlighting systems,* The University of Michigan Transportation Research Institute and General Motors LLC, UMTRI–2019–6.

[91] For GM's Lane Chane Alert systems, sensors in the vehicle's rear bumper are utilized to warn the driver of vehicles approaching from the rear on either the left or right side.

[92] Forkenbrock, G., Hoover, R.L., Gerdus, E., Van Buskirk, T.R., & Heitz, M. (2014, July), *Blind spot monitoring in light vehicles—System performance* (Report No. DOT HS 812 045), Washington, DC: National Highway Traffic Safety Administration.

NHTSA is proposing to conduct BSW tests in NCAP in accordance with the Agency's BSW test procedure. The Agency believes that the Straight Lane Pass-by Test scenario, which stipulates incrementally higher test speeds for the POV, could be used to distinguish between vehicles that have basic versus advanced BSW capability. For instance, an SV that can only satisfy the BSW activation criteria when the POV approaches with a low relative velocity may be considered as having basic BSW capability, whereas a vehicle that can look further rearward, to sense a passing vehicle travelling at a much higher speed, may be considered to have superior BSW capability. NHTSA believes such an assessment is important because when one vehicle encroaches into the adjacent lane of the other, the crashes associated with higher speed differentials can be expected to be more severe than those that occur when the two vehicle speeds are more similar. Furthermore, the capability of a vehicle to detect when another vehicle has entered an extended rear zone could be important for the application of other ADAS technologies such as blind spot intervention (BSI) or SAE[93] Level 2 partial driving automation[94] systems that incorporate automatic lane change features. Therefore, the Agency believes that long-range vehicle detection may not only increase the effectiveness of blind spot technologies such as BSI, but also enhance capabilities and robustness of other ADAS applications. For these reasons, NHTSA is proposing (later in this notice) the incorporation of BSI technology in NCAP to encourage the proliferation of such systems along with sensing strategies that offer a greater field of view.

Commenters to NHTSA's December 2015 notice overwhelmingly supported the addition of BSW in NCAP. In fact, many commenters suggested the Agency expand the testing requirements to encompass additional test targets, such as motorcycles, and test conditions. Several commenters also recommended that NHTSA harmonize its BSW test procedure with International Organization for Standardization (ISO) standards. Each of these topics will be discussed below.

a. Additional Test Targets and/or Test Conditions

Commenters, including the ASC, Continental, Bosch, NSC, and others, recommended that the Agency expand the BSW testing requirements to include motorcycle detection. Delphi, MTS, Medical College of Wisconsin (MCW), and CU suggested that NHTSA evaluate a vehicle's ability to detect bicycles in addition to motorcycles. Similarly, Subaru suggested that changes to the Straight Lane Pass-by Test should be made to address motorcycle detection. MTS and MCW added that motorcycle riders and bicyclists are more vulnerable to serious and fatal injuries compared to occupants of motor vehicles. A few commenters were not supportive of adding a motorcycle detection test in NCAP. Global Automakers and Hyundai stated that although it was a reasonable goal for the future, no standardized test devices currently existed at the time. Similarly, Honda and the Alliance recommended that the Agency focus on vehicle detection as a first step since no standard test procedure exists for motorcycle detection. The Alliance added that since the location of a motorcycle within a lane can vary greatly, test procedures would need to specify motorcycle behavior and reasonable detection distances. Furthermore, MTS stated that the position of the motorcycle POV within the lane (near, center, far) should be specified, and the radar cross section and projected area of the motorcycle should be considered as well.

NHTSA agrees that BSW systems capable of detecting motorcycles would improve safety. A review of the 2011 through 2015 FARS and GES data sets[95] showed that there were 106 fatal crashes and nearly 5,100 police-reported crashes annually, on average, for same direction lane change crashes involving a vehicle and motorcycle. In comparison, as mentioned earlier, there were 542 fatalities and 503,070 police-reported crashes annually, on average, for lane change crashes involving motor vehicles. These data show that more occupants of motor vehicles die in lane changing crashes than do motorcyclists. However, the fatality rate for motorcyclists is greater than that for vehicle occupants.

At this time, the Agency has decided to prioritize testing of BSW systems on motor vehicles for NCAP. NHTSA believes that performing BSW testing on light vehicles, particularly at higher POV closing speeds, and for active safety systems (as will be discussed next), should encourage development of robust sensing systems, which may improve the detection of other objects such as motorcycles. That being said, the Agency has planned an upcoming research project designed to address injuries and fatalities for other vulnerable road users, specifically motorcyclists. The Agency will continue to observe the development of BSW technology and is likely to include test procedures for motorcycle detection in NCAP at a later date if the technology meets the four prerequisites mentioned above.

Several commenters offered additional suggestions for ways NHTSA could expand the BSW test procedure. MCW suggested that the Agency adopt test scenarios that address curved roads and low light conditions. CU proposed that the Agency should assess whether BSW systems provide a clear indication to the driver that the system is not operating since sensors are sometimes rendered inoperable in poor weather or when blocked.

As with all the ADAS technologies, NHTSA recognizes that there is a need to understand and assure crash mitigation performance of BSW systems under all practical situations that the driver and vehicle will encounter in the real world. However, such comprehensive testing is not always practical within the scope of the NCAP program. Thus, for technologies that met the four principles for inclusion in NCAP, the Agency primarily attempted to address the most frequently occurring, most fatal, and most injurious pre-crash scenarios when prioritizing tests to add to the program. When ADAS technologies penetrate the fleet in sufficient numbers, then the Agency can evaluate how these systems are performing in the real world and adjust the system performance criteria accordingly to address additional test conditions, such as those mentioned by MCW. Regarding CU's suggestion, the Agency believes, after reviewing vehicle owner's manuals, that most vehicle manufacturers are including provisions in their system designs to provide a malfunction indicator to the driver if the system is no longer operational because the sensors are blocked or due to severe weather conditions.

NHTSA has also considered Bosch's request to expand the definition of BSW to encourage adoption of systems that provide longer detection distances. NHTSA believes, as discussed above,

---

[93] SAE International (2018), *SAE J3016_201806: Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles,* Warrendale, PA, *www.sae.org.*

[94] The sustained driving automation system of both the lateral and longitudinal vehicle motion control with the expectation that the driver supervises the driving automation system.

[95] Swanson, E., Azeredo, P., Yanagisawa, M., & Najm, W. (2018, September), Pre-Crash Scenario Characteristics of Motorcycle Crashes for Crash Avoidance Research (Report No. DOT HS 812 902), Washington, DC: National Highway Traffic Safety Administration. In Press

that by using higher POV closing speeds to assess BSW system performance, it may effectively drive enhanced blind spot system capabilities such as those required for other rearward-looking ADAS applications, like BSI, or automatic lane change functions.

b. Test Procedure Harmonization

Several commenters suggested that NHTSA harmonize its BSW test procedure with International Organization for Standardization (ISO) standard 17387:2008, *Intelligent transport systems—Lane change decision aid systems (LCDAS)—Performance requirements and test procedures* or with various aspects of this standard. Global Automakers and Hyundai commented that NHTSA should shift the forward edge of the blind zone rearward from the outside rearview mirrors to the eye point of a 95th percentile person, as specified in ISO 17387. Hyundai stated that the ISO procedure is designed such that when the POV is in-line with the SV driver's eye ellipse, the driver's peripheral vision allows him/her to see the POV without the assistance of BSW systems. The ASC, Continental, and Subaru also suggested that the Agency align the warning zones in the Agency's BSW test procedure with those specified in ISO 17387.

The Agency does not agree with commenters' suggestion to adopt the ISO procedure for defining the forward edge of the blind zone as measured using the eye ellipse from a seated 95th percentile person. NHTSA believes that the blind zone should be defined not by a specific seated individual but by the vehicle's characteristics, since a real-world blind spot for any particular vehicle would differ depending on the size characteristics of the individual driving the vehicle at the time. Since people vary in size, they will sit in different seating positions and have different seating preferences. For instance, a 95th percentile male will be seated more rearward whereas a 5th percentile female will be seated more forward. In addition, drivers have personal preferences for adjusting their side view mirrors that may not be considered optimal and may not provide a full field of view when checking the mirrors to make change lanes. For these reasons, the Agency tentatively concludes that it is more appropriate and better for the safety of consumers to set the forward plane of the blind zone at the rearmost part of the side view mirrors, as specified in its BSW test procedure. This approach should not only best accommodate a wide variety of driver sizes and seating positions, but also reduce test complexity when defining the blind zone.

2. Adding Blind Spot Intervention (BSI)

Blind spot intervention (BSI) systems are similar to AEB and LKS systems in that they provide active intervention to help the driver avoid a collision with another vehicle. BSW systems alert a driver that a vehicle is in his/her blind spot, whereas BSI systems activate when the BSW alert is ignored, and intervene either by automatically applying the vehicle's brakes or providing a steering input to guide the vehicle back into the unobstructed lane. With their active capability, BSI systems can help a driver avoid collisions with other vehicles that are approaching the vehicle's blind spot, in addition to preventing crashes with vehicles operating within the vehicle's blind spot.

Like BSW systems, BSI systems utilize rear-facing sensors to detect other vehicles that are next to or behind the vehicle in adjacent lanes. Depending on the design of these systems, BSI activation may or may not require the driver to operate his/her turn signal indicator during a lane change. Furthermore, some BSI systems may only operate if the vehicle's BSW system is also enabled.

As discussed earlier, UMTRI found that GM's BSW system, Side Blind Zone Alert, produced a non-significant 3 percent reduction in lane change crashes. However, when Side Blind Zone Alert was combined with a later generation technology, GM's Lane Change Alert, the corresponding effectiveness increased to 26 percent.[96] Given BSI is only now penetrating the fleet, NHTSA is unaware of any effectiveness studies for this technology. However, as discussed earlier, the Agency believes that active safety technologies are more effective than warning technologies. The UMTRI study concluded that AEB is more effective than FCW alone and that LKS is more effective than LDW. The Agency believes the same relationship will likely hold true for blind spot systems, and that BSI will be more effective than BSW alone. NHTSA also believes, as mentioned above, that adopting ADAS technologies such as BSI should also encourage development of enhanced BSW system capabilities (*e.g.,* motorcycle and bicycle detection), and may increase the robustness of other ADAS applications.

NHTSA is proposing to use its published draft test procedure titled, ''Blind Spot Intervention System Confirmation Test,'' [97] to evaluate the performance of vehicles equipped with BSI technology in NCAP. The Agency's test procedure consists of three scenarios: Subject Vehicle (SV) Lane Change with Constant Headway, SV Lane Change with Closing Headway, and SV Lane Change with Constant Headway, False Positive Assessment. In the first two scenarios, an SV initiates or attempts a lane change into an adjacent lane while a single POV is residing within the SV's blind zone (Scenario 1), or is approaching it from the rear (Scenario 2). The third scenario is used to evaluate the propensity of a BSI system to activate inappropriately in a non-critical driving scenario that does not present a safety risk to the occupants in the SV. In each of the tests, the POV is a strikeable object with the characteristics of a compact passenger car. The system performance requirements stipulate that the SV may not contact the POV during the conduct of any test trial. NHTSA is requesting comment on the number of trials that are appropriate for each test. Each of these scenarios, along with the proposed evaluation criteria, is detailed below: [98]

- SV Lane Change with Constant Headway—The POV is driven at 72.4 kph (45 mph) in a lane adjacent and to the left of the SV also traveling at 72.4 kph (45 mph) with a constant longitudinal offset such that the front-most part of the POV is 1 m (3.3 ft.) ahead of the rear-most part of the SV. After a short period of steady-state driving, the SV driver engages the left turn signal indicator at least 3 s after all pre-SV lane change test validity criteria have been satisfied. Within 1.0 ± 0.5 s after the turn signal has been activated, the SV driver initiates a manual lane change into the POV's travel lane. The SV driver then releases the steering wheel within 250 ms of the SV exiting a 800.1 m (2,625 ft.) radius curve during the lane change. To meet the performance criteria, the BSI system must intervene so as to prevent the left rear of the SV from contacting the right front of the POV. Additionally, the SV

---

[96] Leslie, A.J., Kiefer, R.J., Meitzner, M.R., & Flannagan, C.A. (2019), *Analysis of the field effectiveness of General Motors production active safety and advanced headlighting systems,* The University of Michigan Transportation Research Institute and General Motors LLC, UMTRI–2019–6.

[97] 84 FR 64405 (Nov. 21, 2019).

[98] The Agency notes that these test scenario descriptions assume the SV is operating in SAE Automation Level 0 or Level 1 operation with only the Automatic Cruise Control (ACC) enabled. Though the Agency's BSI test procedure has provisions to evaluate vehicles operating in SAE Automation Levels 2 or 3. Test scenario descriptions for these evaluations are not discussed herein.

BSI intervention shall not cause the SV to travel 1.0 ft. (0.3 m) or more beyond the inboard edge of the lane line separating the SV travel lane from the lane adjacent and to the right of it within the validity period.

- SV Lane Change with Closing Headway Scenario—The POV is driven at a constant speed of 80.5 kph (50 mph) towards the rear of the SV in an adjacent lane to the left of the SV, which is traveling at a constant speed of 72.4 kph (45 mph). During the test, the SV driver engages the turn signal indicator when the POV is 4.9 ± 0.5 s from a vertical plane defined by the rear of the SV and perpendicular to the SV travel lane. Within 1.0 ± 0.5 s after the turn signal has been activated, the SV driver initiates a manual lane change into the POV's travel lane. The SV driver then releases the steering wheel within 250 ms of the SV exiting a 800.1 m (2,625 ft.) radius curve. To meet the performance criteria, the BSI system must intervene to prevent the left rear of the SV from contacting the right front of the POV. Additionally, the SV BSI intervention shall not cause the SV to travel 1.0 ft. (0.3 m) or more beyond the inboard edge of the lane line separating the SV travel lane from the lane adjacent and to the right of it within the validity period.
- SV Lane Change with Constant Headway, False Positive Assessment Test—The POV is driven at 72.4 kph (45 mph) in a lane that is two lanes to the left of the SV's initial travel lane with a constant longitudinal offset such that the front-most part of the POV is 1 m (3.3 ft.) ahead of the rear-most part of the SV, which is also travelling at 72.4 kph (45 mph). The SV driver engages the left turn signal indicator at least 3 s after all pre-SV lane change test validity criteria have been satisfied. Within 1.0 ± 0.5 s after the turn signal has been activated, the SV driver initiates a manual lane change into the left adjacent lane (the one between the SV and POV). For this test, the driver does not release the steering wheel. Since the lane change will not result in an SV-to-POV impact, the SV BSI system must not intervene during any valid trials. To determine whether a BSI intervention occurred, the SV yaw rate data collected during the individual trials performed in this scenario are compared to a baseline composite. After being aligned in time to the baseline, the difference between the data must not exceed 1 degree/second within the test validity period.

The proposed crash-imminent BSI test scenarios represent pre-crash scenarios that correspond to a substantial portion of fatalities and injuries observed in real-world lane change crashes. As discussed in the BSW crash statistics section, Volpe showed that approximately 28 percent of fatalities and 57 percent of injuries in lane change crashes occurred on roads with posted speeds of 72.4 kph (45 mph) or lower.[99] Furthermore, approximately 14 percent of fatalities and 24 percent of injuries were reported for crashes that occurred at known travel speeds of 72.4 kph (45 mph) or lower.[100]

NHTSA has conducted a series of tests utilizing its proposed BSI test procedure. Since BSI systems are not widely available in the fleet, the Agency selected vehicles in order to cover as many manufacturers as possible that have implemented this technology. All vehicles selected for BSW testing also underwent BSI testing. Test reports related to both test programs can be found in the docket for this notice. For the purposes of this testing, the Agency used the Global Vehicle Target (GVT) Revision G to represent the POV, which is specified in the BSI test procedure as a strikeable object.[101] When the BSI technology assessment is incorporated into NCAP, the Agency plans to use the GVT Revision G as a strikeable target to be consistent with Euro NCAP's ADAS test procedures that specify a strikeable target. In the context of testing BSW and BSI technologies in NCAP to address lane change crashes, NHTSA is seeking comment on the following:

(16) Should all BSW testing be conducted without the turn signal indicator activated? Why or why not? If the Agency was to modify the BSW test procedure to stipulate activation of the turn signal indicator, should the test vehicle be required to provide an audible or haptic warning that another vehicle is in its blind zone, or is a visual warning sufficient? If a visual warning is sufficient, should it continually flash, at a minimum, to provide a distinction from the blind spot status when the turn signal is not in use? Why or why not?

(17) Is it appropriate for the Agency to use the Straight Lane Pass-by Test to quantify and ultimately differentiate a vehicle's BSW capability based on its ability to provide acceptable warnings when the POV has entered the SV's blind spot (as defined by the blind zone) for varying POV–SV speed differentials? Why or why not?

(18) Is using the GVT as the strikeable POV in the BSI test procedure appropriate? Is using Revision G in NCAP appropriate? Why or why not?

(19) The Agency recognizes that the BSW test procedure currently contains two test scenarios that have multiple test conditions (*e.g.,* test speeds and POV approach directions (left and right side of the SV)). Is it necessary for the Agency to perform all test scenarios and test conditions to address the real-world safety problem adequately, or could it test only certain scenarios or conditions to minimize test burden in NCAP? For instance, should the Agency consider incorporating only the most challenging test conditions into NCAP, such as the ones with the greatest speed differential, or choose to perform the test conditions having the lowest and highest speeds? Should the Agency consider only performing the test conditions where the POV passes by the SV on the left side if the vehicle manufacturer provides test data to assure the left side pass-by tests are also representative of system performance during right side pass-by tests? Why or why not?

(20) Given the Agency's concern about the amount of system performance testing under consideration in this RFC, it seeks input on whether to include a BSI false positive test. Is a false positive assessment needed to insure system robustness and high customer satisfaction? Why or why not?

(21) The BSW test procedure includes 7 repeated trials for each test condition (*i.e.,* test speed and POV approach direction). Is this an appropriate number of repeat trials? Why or why not? What is the appropriate number of test trials to adopt for each BSI test scenario, and why? Also, what is an appropriate pass rate for each of the two tests, BSW and BSI, and why is it appropriate?

(22) Is it reasonable to perform only BSI tests in conjunction with activation of the turn signal? Why or why not? If the turn signal is not used, how can the operation of BSI be differentiated from the heading adjustments resulting from an LKS intervention? Should the SV's LKS system be switched off during conduct of the Agency's BSI evaluations? Why or why not?

C. Adding Pedestrian Automatic Emergency Braking (PAEB)

Another important ADAS technology NHTSA proposes to include in its upgrade of NCAP is pedestrian automatic emergency braking (PAEB).

---

[99] The posted speed limit was either not reported or was unknown in 2 percent of fatal lane change crashes and 18 percent of lane change crashes that resulted in injuries.

[100] The travel speed was either not reported or was unknown in 65 percent of fatal lane change crashes and 67 percent of lane change crashes that resulted in injuries.

[101] The GVT is a three-dimensional surrogate that resembles a white hatchback passenger car. It is currently used by other consumer organizations, including Euro NCAP, and vehicle manufacturers in their internal testing of ADAS technologies. See Section III.D.2. of this notice for an expanded discussion of the GVT.

PAEB systems function similar to AEB systems but detect pedestrians instead of vehicles. PAEB uses information from forward-looking sensors to issue a warning and actively apply the vehicle's brakes when a pedestrian, or sometimes a cyclist, is in front of the vehicle and the driver has not acted to avoid the impending impact. Similar to AEB, PAEB systems typically use cameras to determine whether a pedestrian is in imminent danger of being struck by the vehicle, but some systems may use a combination of cameras, radar, lidar, and/or thermal imaging sensors.

Many pedestrian crashes occur when a pedestrian is in the forward path of a driver's vehicle. Four common pedestrian crash scenarios include when the vehicle is:

1. Heading straight and a pedestrian is crossing the road;
2. Turning right and a pedestrian is crossing the road;
3. Turning left and a pedestrian is crossing the road; and
4. Heading straight and a pedestrian is walking along or against traffic.

These four crash scenarios are defined as Scenarios S1–S4, respectively, by the Crash Avoidance Metrics Partnership (CAMP) Crash Imminent Braking (CIB) Consortium.[102]

Two of these scenarios, S1 and S4, are included in NHTSA's draft research PAEB test procedure, published on November 21, 2019, and referenced herein as the 2019 PAEB test procedure.[103] The S1 scenario represents a pedestrian crossing the road in front of the vehicle, while the S4 scenario represents a pedestrian moving with or against traffic along the side of the road in the path of the vehicle. Both test scenarios are repeated for multiple pedestrian impact locations. The S1 and S4 crash scenarios were chosen for inclusion in NHTSA's 2019 PAEB test procedure because a review of pedestrian crashes from the 2011 through 2012 GES and FARS data sets[104] found that, on average, these two pre-crash scenarios (S1 and S4) accounted for approximately 33,000 (52 percent) of vehicle-pedestrian crashes and 3,000 (90 percent) fatal vehicle-pedestrian crashes with a light-vehicle striking a pedestrian as the first event. Furthermore, these crashes accounted for 67 percent of MAIS 2+ and 76 percent of MAIS 3+ injured pedestrians.[105] The 2019 PAEB test procedure only considered daylight test conditions for both the S1 and S4 crash scenarios.

The Agency's 2019 PAEB test procedure does not include CAMP scenario S2 (vehicle turning right and a pedestrian crossing the road), and CAMP scenario S3 (vehicle turning left and a pedestrian crossing the road). In response to the December 2015 notice, several commenters stated that addressing these scenarios with available technology may generate a significant number of false positive detections. Such false detections could have the unintended consequences of causing hazardous situations (*e.g.,* unexpected sudden braking while turning in traffic) that could lead drivers to disable their PAEB systems, or even lead to an increase in rear-end collisions. The commenters explained that the S2 and S3 test scenarios require more sophisticated algorithms as well as more robust test methodologies than those required for scenarios S1 and S4. However, ZF TRW mentioned that ADAS sensors designed to meet Euro NCAP's Vulnerable Road Users test procedures would have increased fields of view (FOV), which should improve their effectiveness in turning scenarios. Others stated that the articulating mannequins may not be representative of a real human for all sensing technologies in turning scenarios. Most commenters indicated that it was more appropriate to focus on the scenarios affording the most significant safety benefits first—S1 and S4. Commenters stated that adding the S2 and S3 scenarios would be more practical when the technology matures. NHTSA will continue to evaluate PAEB systems to assess the feasibility of expanding the suite of PAEB tests as technological advancements are made. The Agency will consider adding these test scenarios (S2 and S3) to NCAP in the future once the Agency has repeatable and reliable test data to support their inclusion.

In the 2019 PAEB test procedure, the S1 test scenario includes seven different test conditions—S1a, S1b, S1c, S1d, S1e, S1f, and S1g. For these tests, the SV travels in a straight, forward direction at 40 kph (24.9 mph). Additionally, the SV also travels at 16 kph (9.9 mph) for test conditions S1a, S1b, S1c, and S1d. A pedestrian mannequin crosses perpendicular to the subject vehicle's line of travel at 5 kph (3.1 mph) for all test conditions, except for S1e, in which the mannequin crosses at 8 kph (5.0 mph). In test condition S1a, the SV encounters a crossing adult pedestrian mannequin walking from the nearside (*i.e.,* the passenger's side of the vehicle) with 25 percent overlap of the vehicle.[106] In test conditions S1b and S1c, the SV encounters a crossing adult pedestrian walking from the nearside with 50 percent and 75 percent overlap of the vehicle, respectively. In test condition S1d, the SV encounters a crossing child pedestrian mannequin running from behind parked vehicles from the nearside with 50 percent overlap of the vehicle. In test condition S1e, the SV encounters a crossing adult pedestrian running from the ''offside'' (*i.e.,* the driver's side of the vehicle) with 50 percent overlap of the vehicle. In test condition S1f, the SV encounters a crossing adult pedestrian walking from the nearside that stops short (−25% overlap) of entering the vehicle's path. In test condition S1g, the SV encounters a crossing adult pedestrian walking from the nearside that clears the vehicle's path (125% overlap).

The S4 test scenario in the 2019 PAEB test procedure includes three different test conditions—S4a, S4b, and S4c. In this test scenario, the SV travels in a straight, forward direction at 40 kph (24.9 mph) and/or 16 kph (9.9 mph) (for test conditions S4a and S4b) and a pedestrian mannequin moves parallel to the flow of traffic at 5 kph (3.1 mph) (for test condition S4c) or is stationary (for test condition S4a and S4b) in front of the SV. For all S4 test conditions, the SV is aligned to impact the pedestrian at 25 percent overlap. In test condition S4a, the SV encounters an adult pedestrian standing in front of the vehicle on the nearside of the road facing away from the approaching SV. In test condition S4b, the SV encounters an adult pedestrian standing in front of the vehicle on the nearside of the road facing towards the approaching SV. In test condition S4c, the SV encounters an adult pedestrian walking in front of the vehicle on the nearside of the road facing away from the approaching SV.

---

[102] Carpenter, M.G., Moury, M.T., Skvarce, J.R., Struck, M. Zwicky, T. D., & Kiger, S.M. (2014, June), *Objective tests for forward looking pedestrian crash avoidance/mitigation systems: Final report* (Report No. DOT HS 812 040), Washington, DC: National Highway Traffic Safety Administration.

[103] 84 FR 64405 (Nov. 21, 2019).

[104] Yanagisawa, M., Swanson, E., Azeredo, P., & Najm, W.G. (2017, April), *Estimation of potential safety benefits for pedestrian crash avoidance/mitigation systems* (Report No. DOT HS 812 400), Washington, DC: National Highway Traffic Safety Administration.

[105] As explained previously, the Abbreviated Injury Scale (AIS) is a classification system for assessing impact injury severity. AIS ranks individual injuries by body region on a scale of 1 to 6 where 1 = minor, 2 = moderate, 3 = serious, 4 = severe, 5 = critical, and 6 = maximum (untreatable). MAIS represents the maximum injury severity, or AIS level, recorded for an occupant (*i.e.,* the highest single AIS for a person with one or more injuries).

[106] Overlap is defined as the percent of the vehicle's width that the pedestrian would traverse prior to impact if the vehicle's speed and pedestrian's speed remain constant.

The Agency is proposing to make several changes to the 2019 PAEB test procedure for the purpose of adopting it for use in NCAP. These changes involve the pedestrian mannequins, test speeds and included test conditions, the specified lighting conditions, and the number of test trials required to be conducted for each test condition.

The first change the Agency is proposing to make to the 2019 PAEB test procedure concerns the pedestrian targets. As was recommended by several commenters who responded to the December 2015 notice, the Agency proposes to utilize state-of-the-art mannequins with articulated, moving legs, instead of the posable child and adult pedestrian test mannequins specified in the 2019 PAEB test procedure. NHTSA believes that the articulating pedestrian targets are more representative of walking pedestrians and expects that these more realistic targets will encourage development of PAEB systems that detect, classify, and respond to pedestrians more accurately and effectively. In turn, this should allow manufacturers to improve the effectiveness of current PAEB systems. The Agency also recognizes that adopting the child and adult articulating targets would harmonize with other major consumer information-focused entities that use articulating mannequins, such as Euro NCAP and IIHS. The Bipartisan Infrastructure Law mandated that NHTSA identify opportunities where NCAP would ''benefit from harmonization with third-party safety rating programs,'' and the Agency believes that the pedestrian mannequins represent one such opportunity.

The second change the Agency is proposing to make to the 2019 PAEB test procedure for incorporation into NCAP involves test speeds. The test speeds specified in the 2019 PAEB test procedure correspond to a relatively small percentage of crashes that result in pedestrian injuries and fatalities. Volpe's analysis of 2011–2015 FARS and GES crash data sets showed that 9 percent of pedestrian fatalities and 25 percent of pedestrian injuries resulted from crashes that occurred on roadways with posted speeds of 40.2 kph (25 mph) or less, whereas 88 percent of fatalities and 43 percent of injuries occurred for crashes on roadways with posted speeds greater than 40.2 kph (25 mph).[107] [108] For crashes that occurred on roadways where the travel speed was known, 6 percent of pedestrian fatalities and 19 percent of pedestrian injuries were reported for travel speeds of 40.2 kph (25 mph) or less, whereas 36 percent of fatalities and 7 percent of injuries occurred for travel speeds greater than 40.2 kph (25 mph).[109] NHTSA notes that speeding was a factor in only 5 percent of the fatal pedestrian crashes, which suggests that the posted speed could correlate closely with the travel speed of the vehicle prior to impact with the pedestrian.[110] [111]

As Volpe's analysis focused on 2011–2015 FARS and GES crash data sets, it is likely that most vehicles studied were not equipped with PAEB systems. Recently, IIHS studied approximately 1,500 police-reported crashes involving a wide variety of 2017–2020 model year vehicles from various manufacturers to examine the effects of PAEB systems on real-world pedestrian crashes.[112] In this study, the Institute found that ''pedestrian AEB was associated with a 32 percent reduction in the odds of a pedestrian crash on roads with speed limits of 25 mph or less and a 34 percent reduction on roads with 30–35 mph limits, but no reduction at all on roads with speed limits of 50 mph or higher. . .''. These findings highlight the limitations of existing PAEB systems and the importance of adopting higher test speeds for PAEB testing (where feasible) to encourage additional safety improvement.

To establish feasible speed thresholds for adoption in its PAEB test procedure, the Agency conducted a series of tests on a selection of MY 2020 vehicles from various manufacturers to assess the operational range and performance of current PAEB systems. Vehicles for the PAEB characterization tests were selected with the intent of testing a variety of vehicle makes, types, sizes; global and domestic products; and forward-facing sensor types (camera only, stereo camera, fused camera plus radar, etc.) for a given manufacturer and across all manufacturers.

For the purpose of this study, the Agency used the 2019 PAEB test procedure, but employed the articulating mannequins in lieu of the posable mannequins and expanded the test procedure specifications to include increased vehicle test speeds for the S1b, S1d, S1e, S4a, and S4c test conditions. For these tests, the SV speed was incrementally increased to identify when each SV reached its operational limits and did not respond to the pedestrian target. Before the tests were initiated, the maximum test speeds for the S1 and S4 scenarios were set to 60 kph (37.2 mph) and 80 kph (49.7 mph), respectively.[113] These maximum speeds are consistent with Euro NCAP's AEB Vulnerable Road User test protocol and correspond to up to 74 percent of fatal pedestrian crashes and 65 percent of injurious pedestrian crashes that occurred on U.S. roadways, per Volpe's 2011–2015 FARS and GES analysis of posted speed data.[114] When no or late intervention occurred for a vehicle and test condition (*i.e.,* combination of test scenario and speed), NHTSA repeated the test condition at a test speed that was 5 kph (3.1 mph) lower. This reduced speed defined the system's upper capabilities.

A test matrix of the PAEB characterization study regarding test speed is provided below.

- Full PAEB test series (includes S1 a–g and S4 a–c)

Daytime light conditions, articulating dummies, and additional SV test speeds in kph (mph) for S1b, d, and e, and S4a and c, as shown in Table 4.

---

[107] Swanson, E., Foderaro, F., Yanagisawa, M., Najm, W.G., & Azeredo, P. (2019, August), *Statistics of light-vehicle pre-crash scenarios based on 2011–2015 national crash data* (Report No. DOT HS 812 745), Washington, DC: National Highway Traffic Safety Administration.

[108] The posted speed limit was either not reported or was unknown in 4 percent of fatal pedestrian crashes and 29 percent of pedestrian crashes that resulted in injuries.

[109] The travel speed was either not reported or was unknown in 59 percent of fatal pedestrian crashes and 72 percent of pedestrian crashes that resulted in injuries.

[110] Swanson, E., Foderaro, F., Yanagisawa, M., Najm, W.G., & Azeredo, P. (2019, August), *Statistics of light-vehicle pre-crash scenarios based on 2011–2015 national crash data* (Report No. DOT HS 812 745), Washington, DC: National Highway Traffic Safety Administration.

[111] In 4 percent of pedestrian crashes, it was unknown or not reported whether speeding was a factor.

[112] Cicchino, J.B. (2022, February), *Effects of automatic emergency braking systems on pedestrian crash risk,* Insurance Institute for Highway Safety, *https://www.iihs.org/api/datastoredocument/bibliography/2243.*

[113] These test speeds represent the maximum test speeds potentially utilized for a given test condition. The actual speeds used for a given combination of vehicle and test condition depended on observed PAEB system performance.

[114] European New Car Assessment Programme (Euro NCAP). (2019, July). *TEST PROTOCOL—AEB VRU systems* 3.0.2.

TABLE 4—COMPLETE MATRIX OF THE PAEB CHARACTERIZATION STUDY

Scenario	S1a	S1b	S1c	S1d	S1e	S1f	S1g	S4a	S4b	S4c
Subject Vehicle Speed (kph/mph)	16.0/9.9 40.0/24.9	16.0/9.9 20.0/12.4 30.0/18.6 40.0/24.9 50.0/31.1 60.0/37.3	16.0/9.9 40.0/24.9	16.0/9.9 20.0/12.4 30.0/18.6 40.0/24.9 50.0/31.1 60.0/37.3	40.0/24.9 50.0/31.1 60.0/37.3	40.0/24.9	40.0/24.9	16.0/9.9 40.0/24.9 50.0/31.1 60.0/37.3 70.0/43.5 80.0/49.7	16.0/9.9 40.0/24.9	16.0/9.9 40.0/24.9 50.0/31.1 60.0/37.3 70.0/43.5 80.0/49.7

The Agency's characterization testing showed that many MY 2020 vehicles were able to repeatedly avoid impacting the pedestrian mannequins at higher test speeds than those specified in the 2019 PAEB test procedure. In fact, several vehicles repeatably achieved full crash avoidance at speeds up to 60 kph (37.3 mph) or higher for the assessed S1 and S4 test conditions. Test reports related to this testing can be found in the docket for this notice.

In light of these results, NHTSA is proposing to increase the maximum SV test speed from the 40 kph (24.9 mph) specified in the 2019 PAEB test procedure to 60 kph (37.3 mph) for all PAEB test conditions the Agency is proposing to include in NCAP. These include S1a–e and S4a–c. The Agency notes that it is not proposing to include PAEB false positive test conditions (*i.e.,* S1f and S1g) in NCAP at this time, but is requesting comment on whether the omission of these test conditions is appropriate. NHTSA also notes that 60 kph (37.3 mph) is the maximum vehicle speed Euro NCAP uses to assess PAEB performance for test conditions that are similar to, if not identical to, some of those proposed for use in NCAP, namely S1a, c, d, and e, and S4c. Adopting this higher test speed will also drive improved PAEB system performance to address a larger portion of real-world fatalities and injuries.

The Agency is also proposing a minimum test speed of 10 kph (6.2 mph) for all of the proposed test scenarios. Although this speed is lower than the minimum test speed used in the 2019 PAEB test procedure and in its characterization testing (*i.e.,* 16 kph (9.9 mph)), it is the minimum test speed specified in Euro NCAP's pedestrian tests, with the exception of Euro NCAP's Car-to-Pedestrian Longitudinal Adult (CPLA) scenario. The minimum vehicle test speed for the CPLA scenario, which is similar to the Agency's PAEB S4c test scenario, is 20 kph (12.4 mph).[115] As stated earlier, in accordance with the Bipartisan Infrastructure Law, the Agency is taking steps to harmonize with existing consumer information rating programs where possible and when appropriate. NHTSA also believes that reducing the minimum test speed to 10 kph (6.2 mph) will assure PAEB system functionality for crashes that may still cause injuries.

In an effort to harmonize with other consumer information programs on vehicle safety, NHTSA is also proposing to adopt Euro NCAP's approach to assessing vehicles' PAEB system performance by incrementally increasing the SV speed from the minimum test speed for a given scenario to the maximum. The Agency is proposing 10 kph (6.2 mph) increments for this progression in test speed. In their comments to the December 2015 notice, Global Automakers and Mobileye encouraged NHTSA to expand the applicability of the PAEB tests, particularly the S1 scenario, to include a broader range of test speeds because pedestrian injuries occurred over a wide range of crash speeds, as the Agency has also indicated. The organizations also mentioned that PAEB system performance reflects a trade-off between FOV and collision speed/detection distance. Systems that have a narrow FOV are more effective at addressing higher speed crashes since they can see further, and systems that have a wider FOV are more effective at addressing lower speed impacts.

As its third change to the 2019 PAEB test procedure, the Agency is proposing to expand PAEB evaluation to include different lighting conditions. NHTSA's PAEB characterization study included performance assessments for dark lighting conditions (*i.e.,* nighttime testing), in addition to the daylight conditions specified in the 2019 PAEB test procedure, for the same test vehicles. For each vehicle model tested, one set of tests was conducted with the pedestrian mannequin illuminated only by the vehicle's lower beams and a second set of tests with the pedestrian mannequin illuminated by the upper beams. The area where the mannequin was located was not provided any additional (*i.e.,* external) light source. This repeat testing was conducted because Volpe's 2011–2015 FARS data set showed that 36 percent of pedestrian fatalities occurred in the dark with no overhead lights. Test matrices of the PAEB characterization study with respect to dark lighting conditions are provided in Tables 5 and 6.

- PAEB test series (includes S1b, d, and e, and S4a and c)

Dark conditions with lower beams, articulating dummies, and additional SV test speeds in kph (mph), are shown in Table 5.

TABLE 5—PAEB TEST SERIES FOR DARK CONDITIONS WITH LOWER BEAMS

Scenario	S1b	S1d	S1e	S4a	S4c
Subject Vehicle Speed (kph/mph)	16.0/9.9 20.0/12.4 30.0/18.6 40.0/24.9 50.0/31.1 60.0/37.3	16.0/9.9 20.0/12.4 30.0/18.6 40.0/24.9 50.0/31.1 60.0/37.3	40.0/24.9 50.0/31.1 60.0/37.3	16.0/9.9 40.0/24.9 50.0/31.1 60.0/37.3 70.0/43.5 80.0/49.7	16.0/9.9 40.0/24.9 50.0/31.1 60.0/37.3 70.0/43.5 80.0/49.7

---

[115] One difference in the Agency's proposed S4c test condition and Euro NCAP's CPLA test condition is the amount of pedestrian overlap with the vehicle at the lower speed (NHTSA uses a 25 percent overlap while a 50 percent overlap is used in Euro NCAP's CPLA test). NHTSA believes that for the 25 percent overlap condition in S4c, a minimum test speed of 10 kph (6.2 mph) is appropriate and does not see a reason to deviate from the minimum test speed (10 kph (6.2 mph)) proposed for the other PAEB test conditions.

- PAEB test series (includes S1b, d, and e, and S4a and c)

Dark conditions with upper beams, articulating dummies, and additional SV test speeds in kph (mph), are shown in Table 6.

TABLE 6—PAEB TEST SERIES FOR DARK CONDITIONS WITH UPPER BEAMS

Scenario	S1b	S1d	S1e	S4a	S4c
Subject Vehicle Speed (kph/mph)	16.0/9.9	16.0/9.9	40.0/24.9	16.0/9.9	16.0/9.9
	20.0/12.4	20.0/12.4	50.0/31.1	40.0/24.9	40.0/24.9
	30.0/18.6	30.0/18.6	60.0/37.3	50.0/31.1	50.0/31.1
	40.0/24.9	40.0/24.9	....	60.0/37.3	60.0/37.3
	50.0/31.1	50.0/31.1	....	70.0/43.5	70.0/43.5
	60.0/37.3	60.0/37.3	....	80.0/49.7	80.0/49.7

The Agency's characterization testing (Tables 5 and 6) revealed that PAEB system performance generally degraded in dark conditions compared to daylight conditions. Additionally, certain test conditions, such as S1d and S1e, were particularly challenging in dark conditions, especially when the vehicle's lower beams were used. However, a few vehicles were able to repeatedly avoid contact with the pedestrian mannequins at speeds up to 60 kph (37.3 mph) for certain test conditions when the vehicles' lower beams provided the only source of light.

NHTSA's findings for PAEB system performance during testing align generally well with those from IIHS' recent system effectiveness study for 2017–2020 model year vehicles. IIHS found that although PAEB systems were associated with a 32 percent reduction in pedestrian crashes occurring during daylight, and a 33 percent reduction in pedestrian crashes for areas with artificial lighting during dawn, dusk, or at night, there was no evidence that PAEB systems were effective at nighttime without street lighting.[116]

Based on the results of the PAEB characterization study and IIHS' findings in its recent study, NHTSA is proposing to perform the proposed test conditions (S1 a-e and S4 a-c) under daylight conditions and under dark conditions with the vehicle's lower beams. NHTSA notes that Euro NCAP conducts PAEB testing that is similar to the Agency's S4c test condition under dark conditions with vehicles' upper beams in use. Because the Agency cannot be assured that a vehicle's upper beams are in use during nighttime (*i.e.,* dark lighting conditions) real-world driving, NHTSA is proposing only to perform nighttime PAEB assessments using vehicles' lower beams for all test conditions included in NCAP at this time. However, if the SV is equipped with advanced lighting systems such as semiautomatic headlamp beam switching and/or adaptive driving beam head lighting system, they shall be enabled to automatically engage during the nighttime PAEB assessment. The Agency believes this approach covers the two extreme light conditions and as such, information regarding performance with the upper beams or under infrastructure lighting can be reasonably inferred.

The Agency recognizes that Euro NCAP performs testing similar to S1a and S1c at speeds of 10 kph (6.2 mph) to 60 kph (37.3 mph) in dark conditions with the SV lower beams in use; however, overhead streetlights are also used in these tests to provide additional light source. To study potential performance differences attributable to the use of overhead lights during dark conditions, NHTSA performed additional testing for PAEB scenarios S1 b, d, and e and S4 a and c for a subset of test speeds, 16 kph (9.9 mph) and 40 kph (24.9 mph), for two of the MY 2020 vehicles used in its initial characterization study. This study was performed using the vehicles' lower beams under dark conditions with overhead lights. For this limited testing, the Agency observed slightly better PAEB performance in dark lighting conditions with overhead lights than in dark lighting conditions without overhead lights.

NHTSA believes that testing with the vehicles' lower beams in dark conditions without overhead lights is appropriate, particularly at higher test speeds, as it would assure system performance for real-world situations where visibility is the most limited. Furthermore, as mentioned previously, dark lighting conditions with no overhead lights represented 36 percent of pedestrian fatalities and dark lighting conditions with overhead lights represented 39 percent of pedestrian fatalities in Volpe's 2011–2015 FARS data set. Additionally, PAEB systems that meet the performance test specifications under dark lighting conditions with no overhead lights are likely to meet the performance specifications under dark lighting conditions with overhead lights. Thus, the Agency believes assessment of PAEB systems under dark conditions with no overhead lights and with the vehicle's lower beams will encourage vehicle manufacturers to make design improvements to address a significant portion of crashes that currently result in pedestrian fatalities.

For the PAEB performance criteria, NHTSA is proposing that a vehicle must achieve complete crash avoidance (*i.e.,* have no contact with the pedestrian mannequin) in order to pass a test trial conducted at each specified test speed (*i.e.,* 10, 20, 30, 40, 50, and 60 kph (6.2, 12.4, 18.6, 24.9, 31.1, and 37.3 mph)) for each test condition (S1a, b, c, d, and e and S4a, b, and c). NHTSA believes that this approach, used in conjunction with an incremental increase in SV speed, should limit damage to the pedestrian mannequin and/or the SV during testing.

Along these lines, NHTSA is proposing a fourth change to the 2019 PAEB test procedure regarding the number of test trials conducted for each combination of test condition and test speed. The 2019 PAEB test procedure specifies seven test trials be conducted for each test speed under each test condition. The Agency is proposing, however, to not require that more than one test be conducted per test speed and test condition combination if certain criteria are met, and is proposing that the pass rate for a given test speed will be dependent on whether additional test trials are required to be performed.[117]

For a given test condition, the test sequence is initiated at the 10 kph (6.2 mph) minimum speed. To achieve a pass result, the test must be valid (*i.e.,* all test specification and tolerances satisfied), and the SV must not contact

---

[116] Cicchino, J.B. (2022, February), *Effects of automatic emergency braking systems on pedestrian crash risk,* Insurance Institute for Highway Safety, *https://www.iihs.org/api/datastoredocument/bibliography/2243.*

[117] This is a divergence from assessment of LKS, BSW, and BSI where a vehicle must meet performance requirements for five out of seven valid test trials for a particular test condition to pass that test condition.

the pedestrian mannequin. If the SV does not contact the pedestrian mannequin during the first valid test, the test speed is incrementally increased by 10 kph (6.2 mph), and the next test in the sequence is performed. Unless the SV contacts the pedestrian mannequin, this iterative process continues until a maximum test speed of 60 kph (37.3 mph) is evaluated. If the SV contacts the pedestrian mannequin, and the relative longitudinal velocity between the SV and pedestrian mannequin is less than or equal to 50 percent of the initial speed of the SV, the Agency will perform four additional (repeated) test trials at the same speed for which the impact occurred. The vehicle must not contact the pedestrian mannequin for at least three out of the five test trials performed at that same speed to pass that specific combination of test condition and test speed.[118] If the SV contacts the pedestrian mannequin during a valid test of a test condition (whether it be the first test performed for a particular test speed or a subsequent test trial at that same speed), and the relative impact velocity exceeds 50 percent of the initial speed of the SV, no additional test trials will be conducted at the given test speed and test condition and the SV is considered to have failed the test condition at that specific test speed.

The Agency is pursuing an assessment approach for PAEB systems that differs from the evaluation criteria proposed for the other four proposed ADAS technologies discussed earlier in an attempt to reduce test burden, but still ensure that passing systems include robust designs that will afford an enhanced level of safety. NHTSA recognizes that it is proposing a large number of PAEB test conditions for inclusion in NCAP—eight total. The Agency also acknowledges that these test conditions must be repeated for multiple test speeds and lighting conditions, which inherently imposes additional test burden. Therefore, the Agency believes that it is reasonable to reduce the number of test trials that must be conducted at a given test speed for a particular test condition since the SV's PAEB system will also be assessed at subsequent test speeds, which would help system robustness. This would further be supported by the Agency's proposal to require that five test trials be performed in instances where the SV is unable to meet the no contact performance requirement in the initial valid trial for that combination of test condition and speed.

Although NHTSA believes that the assessment approach for PAEB systems proposed herein is the most reasonable one, the Agency is requesting comment on whether it should instead pursue an alternative approach, such as conducting seven trials for each test condition and speed combination, and requiring that five of the seven trials meet the no contact performance criterion. Again, this latter approach would be similar to the one proposed for the other ADAS technologies discussed earlier.

Previously, NHTSA noted that it did not conduct the S2 and S3 test scenarios as part of the characterization study and is not proposing these test scenarios for inclusion in this proposal. The Agency agrees with the comments mentioned previously that the majority of vehicles in the U.S. fleet are not currently equipped with sensing systems capable of detecting pedestrians while a vehicle is turning, as they do not have the necessary FOV. The American Automobile Association (AAA) [119] recently conducted PAEB tests, including an S2 scenario where the vehicle is turning right with an adult pedestrian crossing. The PAEB systems in four model year 2019 vehicles that were tested did not react to the test targets during a testing scenario that is similar to NHTSA's S2 scenario described above, resulting in all test vehicles colliding with the pedestrian target. These systems performed better in a scenario that was similar to NHTSA's S1; however, the vehicles avoided a collision with the pedestrian target 40 percent of the time at a 32.2 kph (20 mph) test speed and nearly all the time at a 48.3 kph (30 mph) test speed. Furthermore, in its recent study on PAEB system effectiveness, IIHS found that while AEB with pedestrian detection was associated with significant reductions in pedestrian crash risk (~27 percent) and pedestrian injury crash risk (~30 percent), there was no evidence to suggest that existing systems were effective while the PAEB-equipped vehicle was turning.[120] Considering these findings, NHTSA believes that it is more beneficial at this time to focus our efforts on performing PAEB testing at higher speeds and with various lighting conditions using the proposed S1 and S4 test scenarios.

In the context of the NCAP PAEB testing program, NHTSA is seeking comment on the following:

(23) Is the proposed test speed range, 10 kph (6.2 mph) to 60 kph (37.3 mph), to be assessed in 10 kph (6.2 mph) increments, most appropriate for PAEB test scenarios S1 and S4? Why or why not?

(24) The Agency has proposed to include Scenarios S1 a-e and S4 a-c in its NCAP assessment. Is it necessary for the Agency to perform all test scenarios and test conditions proposed in this RFC notice to address the safety problem adequately, or could NCAP test only certain scenarios or conditions to minimize test burden but still address an adequate proportion of the safety problem? Why or why not? If it is not necessary for the Agency to perform all test scenarios or test conditions, which scenarios/conditions should be assessed? Although they are not currently proposed for inclusion, should the Agency also adopt the false positive test conditions, S1f and S1g? Why or why not?

(25) Given that a large portion of pedestrian fatalities and injuries occur under dark lighting conditions, the Agency has proposed to perform testing for the included test conditions (*i.e.,* S1 a-e and S4 a-c) under dark lighting conditions (*i.e.,* nighttime) in addition to daylight test conditions for test speed range 10 kph (6.2 mph) to 60 kph (37.3 mph). NHTSA proposes that a vehicle's lower beams would provide the source of light during the nighttime assessments. However, if the SV is equipped with advanced lighting systems such as semiautomatic headlamp beam switching and/or adaptive driving beam head lighting system, they shall be enabled to automatically engage during the nighttime PAEB assessment. Is this testing approach appropriate? Why or why not? Should the Agency conduct PAEB evaluation tests with only the vehicle's lower beams and disable or not use any other advanced lighting systems?

(26) Should the Agency consider performing PAEB testing under dark conditions with a vehicle's upper beams as a light source? If yes, should this lighting condition be assessed in addition to the proposed dark test condition, which would utilize only a vehicle's lower beams along with any advanced lighting system enabled to automatically engage, or in lieu of the proposed dark testing condition?

---

[118] The Agency notes that a similar pass/fail criterion (*i.e.,* a vehicle must meet performance requirements for three out of five trials for a particular test condition to pass the test condition) is included in its LDW test procedure, as referenced earlier.

[119] American Automobile Association (2019, October), *Automatic emergency braking with pedestrian detection, https://www.aaa.com/AAA/common/aar/files/Research-Report-Pedestrian-Detection.pdf.*

[120] Cicchino, J. B (2022, February), *Effects of automatic emergency braking systems on pedestrian crash risk,* Insurance Institute for Highway Safety, *https://www.iihs.org/api/datastoredocument/bibliography/2243.*

Should the Agency also evaluate PAEB performance in dark lighting conditions with overhead lights? Why or why not? What test scenarios, conditions, and speed(s) are appropriate for nighttime (*i.e.,* dark lighting conditions) testing in NCAP, and why?

(27) To reduce test burden in NCAP, the Agency proposed to perform one test per test speed until contact occurs, or until the vehicle's relative impact velocity exceeds 50 percent of the initial speed of the subject vehicle for the given test condition. If contact occurs and if the vehicle's relative impact velocity is less than or equal to 50 percent of the initial SV speed for the given combination of test speed and test condition, an additional four test trials will be conducted at the given test speed and test condition, and the SV must meet the passing performance criterion (*i.e.,* no contact) for at least three out of those five test trials in order to be assessed at the next incremental test speed. Is this an appropriate approach to assess PAEB system performance in NCAP, or should a certain number of test trials be required for each assessed test speed? Why or why not? If a certain number of repeat tests is more appropriate, how many test trials should be conducted, and why?

(28) Is a performance criterion of ''no contact'' appropriate for the proposed PAEB test conditions? Why or why not? Alternatively, should the Agency require minimum speed reductions or specify a maximum allowable SV-to-mannequin impact speed for any or all of the proposed test conditions (*i.e.,* test scenario and test speed combination)? If yes, why, and for which test conditions? For those test conditions, what speed reductions would be appropriate? Alternatively, what maximum allowable impact speed would be appropriate?

(29) If the SV contacts the pedestrian mannequin during the initial trial for a given test condition and test speed combination, NHTSA proposes to conduct additional test trials only if the relative impact velocity observed during that trial is less than or equal to 50 percent of the initial speed of the SV. For a test speed of 60 kph (37.3 mph), this maximum relative impact velocity is nominally 30 kph (18.6 mph), and for a test speed of 10 kph (6.2 mph), the maximum relative impact velocity is nominally 5 kph (3.1 mph). Is this an appropriate limit on the maximum relative impact velocity for the proposed range of test speeds? If not, why? Note that the tests in Global Technical Regulation (GTR) No. 9 for pedestrian crashworthiness protection simulates a pedestrian impact at 40 kph (24.9 mph).

(30) For each lighting condition, the Agency is proposing 6 test speeds (*i.e.,* those performed from 10 to 60 kph (6.2 to 37.3 mph) in increments of 10 kph (6.2 mph)) for each of the 8 proposed test conditions (S1a, b, c, d, and e and S4a, b, and c). This results in a total of 48 unique combinations of test conditions and test speeds to be evaluated per lighting condition, or 96 total combinations for both light conditions. The Agency mentions later, in the ADAS Ratings System section, that it plans to use check marks, as is done currently, to give credit to vehicles that (1) are equipped with the recommended ADAS technologies, and (2) pass the applicable system performance test requirements for each ADAS technology included in NCAP until it issues (1) a final decision notice announcing the new ADAS rating system and (2) a final rule to amend the safety rating section of the vehicle window sticker (Monroney label). For the purposes of providing credit for a technology using check marks, what is an appropriate minimum overall pass rate for PAEB performance evaluation? For example, should a vehicle be said to meet the PAEB performance requirements if it passes two-thirds of the 96 unique combinations of test conditions and test speeds for the two lighting conditions (*i.e.,* passes 64 unique combinations of test conditions and test speeds)?

(31) Given previous support from commenters to include S2 and S3 scenarios in the program at some point in the future and the results of AAA's testing for one of the turning conditions, NHTSA seeks comment on an appropriate timeframe for including S2 and S3 scenarios into the Agency's NCAP. Also, NHTSA requests from vehicle manufacturers information on any currently available models designed to address, and ideally achieve crash avoidance during conduct of, the S2 and S3 scenarios to support Agency evaluation for a future program upgrade.

(32) Should the Agency adopt the articulated mannequins into the PAEB test procedure as proposed? Why or why not?

(33) In addition to tests performed under daylight conditions, the Agency is proposing to evaluate the performance of PAEB systems during nighttime conditions where a large percentage of real-world pedestrian fatalities occur. Are there other technologies and information available to the public that the Agency can evaluate under nighttime conditions?

(34) Are there other safety areas that NHTSA should consider as part of this or a future upgrade for pedestrian protection?

(35) Are there any aspects of NCAP's proposed PAEB test procedure that need further refinement or clarification before adoption? If so, what additional refinement or clarification is necessary, and why?

In addition to the fleet characterization research conducted for this upgrade of NCAP, the Agency is conducting additional research that may be used to support future program enhancements. One such research project is designed to address injuries and fatalities for other vulnerable road users, specifically cyclists.[121] While some PAEB systems may be capable of detecting cyclists and activating to avoid a crash, NHTSA's current PAEB test procedure does not include a specific cyclist component. However, since the number of cyclists killed on U.S. roads continues to rise,[122] the Agency plans to perform research to determine the viability of Euro NCAP's AEB cyclist tests. NHTSA will then compare test data with preliminary crash populations to assess the adequacy of the test procedure for the U.S. vehicle fleet and roadway system. The Euro NCAP test includes four test scenarios: One in which the cyclist crosses in front of the vehicle from the near-side; one in which the cyclist crosses in front of the vehicle from the near-side from behind an obstruction; one in which the cyclist crosses in front of the vehicle from the far-side; and the other in which the cyclist travels in the same direction as the vehicle. The latter test scenario is repeated for both 25 percent and 50 percent overlaps, while the first three scenarios are conducted at 50 percent overlap (*i.e.,* the vehicle strikes the bicyclist at 50 percent of the vehicle's width). In all tests, a cyclist target comprised of an articulating dummy, which replicates the pedaling action of a cyclist, is seated on a bicycle mounted on a moving platform.

NHTSA believes that detecting cyclists is technically more challenging for vehicle AEB systems than detecting pedestrians since cyclists often move at higher speeds. Vehicles must not only be equipped with sensors that have wider fields of view (similar to that required for the turning PAEB test scenarios), but must also process information more quickly as to whether

---

[121] NHTSA notes that this research will also include motorcycles.

[122] National Center for Statistics and Analysis (2019, June), *Bicyclists and other cyclists: 2017 data* (Traffic Safety Facts. Report No. DOT HS 812 765), Washington, DC: National Highway Traffic Safety Administration.

to alert the driver and/or automatically brake.

In the context of this additional research testing, NHTSA requests comment on the following:

(36) Considering not only the increasing number of cyclists killed on U.S. roads but also the limitations of current AEB systems in detecting cyclists, the Agency seeks comment on the appropriate timeframe for adding a cyclist component to NCAP and requests from vehicle manufacturers information on any currently available models that have the capability to validate the cyclist target and test procedures used by Euro NCAP to support evaluation for a future NCAP program upgrade.

(37) In addition to the test procedures used by Euro NCAP, are there others that NHTSA should consider to address the cyclist crash population in the U.S. and effectiveness of systems?

D. Updating Forward Collision Prevention Technologies

As previously mentioned, NHTSA will retain the currently available ADAS technologies (forward collision warning, crash imminent braking and dynamic brake support) designed to address forward collisions (rear-end crashes) in NCAP's crash avoidance program. As discussed in NHTSA's March 2019 study, these technologies have the potential to prevent or mitigate eight rear-end pre-crash scenarios, which represented approximately 1.70 million crashes annually, on average, or 29.4 percent of all crashes that occurred on U.S. roadways. As shown in Table A–1, these crashes resulted in 1,275 fatalities, on average, and 883,386 MAIS 1–5 injuries annually, which represented 3.8 percent of all fatalities and 31.5 percent of all injuries, respectively.[123]

FCW technology evaluations were introduced into NCAP starting with model year 2011 vehicles,[124] while CIB and DBS systems (referred to collectively as Automatic Emergency Braking (AEB)) were added to the program starting with model year 2018 vehicles.[125] These technologies are not being offered as standard equipment on all passenger vehicles, so it remains important for NCAP to recommend the technologies and inform shoppers which vehicles have the technologies. Further, NHTSA observed performance test failures for each of these technologies during NCAP's model year 2019 vehicle performance verification testing;[126] thus, NCAP should continue to inform shoppers as to which systems perform to NHTSA's benchmark. Nonetheless, as will be discussed in the next few sections, NHTSA believes there are opportunities for updating the current NCAP performance requirements for these three technologies.

1. Forward Collision Warning (FCW)

An FCW system is an ADAS technology that monitors a vehicle's speed, the speed of the vehicle in front of it, and the distance between the two vehicles. If the FCW system determines that the distance from the driver's vehicle to the vehicle in front of it is too short, and the closing velocity between the two vehicles is too high, the system warns the driver of an impending rear-end collision.

Typically, FCW systems are comprised of two components: A sensing system, which can detect a vehicle in front of the driver's vehicle; and a warning system, which alerts the driver to a potential crash threat. The sensing portion of the system may consist of forward-looking radar, lidar, camera systems, or a combination of these. The warning system may provide drivers with a visual display, such as a light on the dash, an audible signal (*e.g.,* buzzer or chime), and/or a haptic signal that provides tactile feedback to the driver (*e.g.,* rapid vibrations of the seat pan or steering wheel) to alert the driver of an impending crash so that they may manually intervene (*e.g.,* apply the vehicle's brakes or make an evasive steering maneuver) to avoid or mitigate the crash.

Currently, NCAP's FCW test procedure[127] consists of three scenarios that simulate the most frequent types of rear-end crashes. These include: Lead vehicle stopped (LVS), lead vehicle decelerating (LVD), and lead vehicle moving (LVM) scenarios. In each scenario, the vehicle being evaluated is the SV, and the vehicle positioned directly in front of the SV, a production mid-size passenger car, is the POV. The time-to-collision (TTC) criteria prescribed for each scenario represent the time needed for a driver to perceive an impending rear-end crash, decide the corrective action, and respond with the appropriate mitigating action. The TTC for each scenario is calculated by considering the speed of the SV relative to the POV at the time of the FCW alert. If the FCW system fails to provide an alert within the required time during testing, the professional test driver brakes or steers away to avoid a collision. A short description of each test scenario and the requirements for a passing result based on TTC is provided below:

- LVS—The SV encounters a stopped POV on a straight road. The SV is moving at 72.4 kph (45 mph), and the POV is stationary. To pass this test, the SV must issue an FCW alert when the TTC is at least 2.1 s.
- LVD—The SV encounters a POV slowing with constant deceleration directly in front of it on a straight road. The SV and POV are both driven at 72.4 kph (45 mph) with an initial headway of 30.0 m (98.4 ft.). The POV then decelerates, braking at a constant deceleration of 0.3g in front of the SV. To pass this test, the SV must issue an FCW alert when the TTC is at least 2.4 s.
- LVM—The SV encounters a slower-moving POV directly in front of it on a straight road. The SV and POV are driven at constant speeds of 72.4 kph (45 mph) and 32.2 kph (20 mph), respectively. To pass this test, the SV must issue an FCW alert when the TTC is at least 2.0 s.

Each scenario is conducted up to seven times. To pass the NCAP system performance criteria, the SV must pass at least five out of seven trials[128] for each of the three test scenarios.

NCAP's FCW test scenarios are directly related to real-world crash data. From its analysis of 2011 to 2015 FARS and GES data, the Agency found that crashes analogous to the LVS test scenario, where a struck vehicle was stopped at the time of impact, occurred in 65 percent of the rear-end crashes studied.[129] The LVD scenario, in which

---

[123] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653). Washington, DC: National Highway Traffic Safety Administration.

[124] 73 FR 40016 (July 11, 2008).

[125] 80 FR 68618 (Nov. 5, 2015).

[126] *https://www.regulations.gov,* Docket Nos. NHTSA–2010–0093 and NHTSA–2015–0006. (Only one test failure was observed for FCW.)

[127] National Highway Traffic Safety Administration. (2013, February). *Forward collision warning system confirmation test. https://www.regulations.gov.* Docket No. NHTSA–2006–26555–0134.

[128] As noted in the Agency's 2015 AEB final decision notice (80 FR 68618 (Nov. 5, 2015)), the Agency believes passing five out of seven tests successfully discriminates between functional systems versus non-functional systems. To date, the Agency allows two failures out of seven attempts to afford some flexibility in including emerging technologies into the NCAP program. Furthermore, NHTSA test laboratories have experienced unpredictable vehicle responses due to the vehicle algorithm designs. Test laboratories have observed systems that improve their performance with use, systems degrading and shutting down when they do not see other vehicles, and systems failing to re-activate if the vehicle is not cycled through an ignition cycle.

[129] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653),

the struck vehicle was decelerating at the time of impact, occurred in 22 percent of the rear-end crashes, and the LVM scenario, in which the struck vehicle was moving at a constant, but slower, speed compared to the striking vehicle at impact, occurred in 10 percent of the rear-end crashes. Collectively, these test scenarios represented 97 percent of rear-end crashes. With respect to test speed, in its independent review of the 2011–2015 FARS and GES data sets, Volpe concluded that 28 percent of fatal rear-end crashes and 63 percent of all rear-end crashes occurred on roadways with posted speed limits of 72.4 kph (45 mph) or less.

Currently, NHTSA gives credit on its website by assigning a check mark to vehicles equipped with FCW systems that send visual, audible, and/or haptic alerts and meet the TTC requirements. However, the Agency's research has shown that presenting drivers with an audible warning in medium or high urgency situations significantly reduced crash severity relative to visual and tactile (or haptic) warnings, which did not differ.[130] This being said, in a large-scale field test of FCW and LDW systems on model year 2013 Chevrolet and Cadillac vehicles, the University of Michigan Transportation Research Institute (UMTRI) and GM found that GM's Safety Alert Seat, which provides haptic seat vibration pulses, increased driver acceptance of both FCW and LDW systems compared to audible alerts.[131] The study concluded that the FCW system was turned off 6 percent of the time when the Safety Alert Seat was selected (rather than audible alerts), whereas it was turned off 17 percent of the time when only audible alerts were available. In light of these findings, the Agency seeks comment on whether to give credit to vehicles equipped with FCW systems that only provide a passing audible alert, or whether it should also give credit to those systems that only provide passing haptic alerts.[132] If the Agency elects to give credit to vehicles with haptic alerts, are there certain haptic alert types that should be excluded from consideration (*e.g.,* because they may be such a nuisance to drivers that they may be more likely to disable the system)? NHTSA also seeks comment on whether it should no longer give credit to FCW-equipped vehicles that offer only visual FCW alerts.

NCAP's current FCW test procedure states that if an FCW system provides a warning timing adjustment setting for the driver, at least one timing setting must meet the TTC warning criteria specified in the procedure. Therefore, if a vehicle is equipped with a warning timing adjustment, only the most conservative (*i.e.,* earliest) warning setting is tested. Selecting the most conservative setting is beneficial for track testing where the driver of the SV must steer and/or brake to avoid a crash with the POV after the FCW alert is issued. However, the Agency is concerned that many consumers may not adjust the warning timing setting for FCW alerts. Furthermore, consumers that choose to adjust the alert timing may be unlikely to select the earliest setting, as this setting is most likely to result in false positive alerts (*i.e.,* nuisance alerts) during real-world operation.[133] The Agency also recognizes that the earliest FCW setting can be used to pass the NCAP test—essentially allowing a vehicle to get NCAP credit even though it may not otherwise earn credit if the later warning settings are tested. Therefore, by testing the earliest timing adjustment setting, the Agency's FCW performance assessment may not be indicative of many drivers' real-world experiences.

This concern was previously addressed in NHTSA's 2015 AEB final decision notice, but the Agency has not since made updates to its FCW test procedure.[134] In that notice, the Agency stated that because NCAP is a consumer information program, it should test vehicles as delivered, using the factory default FCW warning adjustment setting for FCW and AEB testing, including PAEB. Although the Agency believes there is still merit to testing the default setting, NHTSA tentatively believes testing the middle alert setting may be more appropriate. Selection of the middle or next latest alert setting for testing would harmonize with Euro NCAP's AEB Car-to-Car systems test protocol, thus potentially driving costs down for manufacturers and attempting to ensure that consumers in both the U.S. and European markets benefit from similar FCW system settings.[135] Harmonization was a common theme among commenters responding to NCAP's December 2015 notice, with most vehicle manufacturers, suppliers, and other industry groups requesting that NHTSA harmonize test procedures, test targets, and test requirements with other NCAPs around the world, particularly Euro NCAP. As mentioned earlier, the Bipartisan Infrastructure Law also required that NHTSA consider harmonization with third-party safety rating programs when possible. In light of these considerations, the Agency is proposing that it is most appropriate to test the middle (or next latest) FCW system setting in lieu of the default setting when performing FCW, CIB, DBS, and PAEB NCAP tests on vehicles that offer multiple FCW timing adjustment settings.

FCW systems have been recognized as the first generation of ADAS technologies designed to help drivers avoid an impending rear-end collision. In 2008, when NHTSA decided to include ADAS in the NCAP program, FCW was selected because the Agency believed (1) this technology addressed a major crash problem; (2) system designs existed that could mitigate this safety problem; (3) safety benefit projections were assessed; and (4) performance tests and procedures were available to ensure an acceptable performance level.[136] At the time, the Agency estimated that FCW systems were 15 percent effective in preventing rear-end crashes. More recently, in a 2017 study, IIHS[137] found that FCW systems may be more effective than NHTSA's initial estimates. IIHS found that FCW systems reduced rear-end crashes by 27 percent. Moreover, consumers have shown favorable acceptance of these systems. For instance, in a 2019 survey of more than 57,000 Consumer Reports subscribers, 69 percent of vehicle owners reported that they were satisfied with their

---

Washington, DC: National Highway Traffic Safety Administration.

[130] Lerner, N., Robinson, E., Singer, J., Jenness, J., Huey, R., Baldwin, C., & Fitch, G. (2014, September), *Human factors for connected vehicles: Effective warning interface research findings* (Report No. DOT HS 812 068), Washington, DC: National Highway Traffic Safety Administration.

[131] Flannagan, C., LeBlanc, D., Bogard, S., Nobukawa, K., Narayanaswamy, P., Leslie, A., Kiefer, R., Marchione, M., Beck, C., and Lobes, K. (2016, February), *Large-scale field test of forward collision alert and lane departure warning systems* (Report No. DOT HS 812 247), Washington, DC: National Highway Traffic Safety Administration.

[132] The Agency would give credit to FCW systems that have both passing audible and haptic alerts if both alert types were available. However, if a vehicle with such a system provided only a passing haptic alert and the Agency decided only to give credit to systems that provided passing audible alerts, then the vehicle would not receive credit as having met the Agency's FCW test requirements.

[133] Nodine, E., Fisher, D., Golembiewski, G., Armstrong, C., Lam, A., Jeffers, M.A., Najm, W., Miller, S., Jackson, S., and Kehoe, N. (2019, May), *Indicators of driver adaptation to forward collision warnings: A naturalistic driving evaluation* (Report No. DOT HS 812 611), Washington, DC: National Highway Traffic Safety Administration.

[134] 80 FR 68614 (Nov. 5, 2015).

[135] European New Car Assessment Programme (Euro NCAP) (2019, July), *Test Protocol—AEB Car-to-Car systems, Version 3.0.2.* See section 7.4.1.1.

[136] 73 FR 40033 (July 11, 2008).

[137] Cicchino, J.B. (2017, February), Effectiveness of forward collision warning and autonomous emergency braking systems in reducing front-to-rear crash rates, *Accident Analysis and Prevention,* 2017 Feb;99(Pt A):142–152. *https://doi.org/10.1016/j.aap.2016.11.009.*

vehicle's FCW technology, 38 percent of vehicle owners said that it had helped them avoid a crash, and 54 percent of them remarked that they trust the system to work every time.[138] As consumer acceptance has been positive, and system performance has improved over the years, fitment rates have also increased. As mentioned previously, less than 0.2 percent of model year 2011 vehicles were equipped with FCW systems compared to 38.3 percent of model year 2018 vehicles.

One limitation of FCW systems is that they are designed to warn the driver, but not to provide significant automatic braking of the vehicle (some FCW systems use haptic brake pulses to alert the driver of a crash-imminent driving situation, but they are not intended to effectively slow the vehicle). Since the introduction of FCW systems into NCAP, active safety systems, such as those with automatic braking capability (*i.e.,* AEB), have entered the marketplace. In a recent study sponsored by GM [139] to evaluate the real-world effectiveness of ADAS technologies (including FCW and AEB) on 3.8 million model year 2013–2017 GM vehicles, UMTRI found that, for frontal collisions, camera-based FCW systems produced an estimated 21 percent reduction in rear-end striking crashes, while the AEB systems studied (which included a combination of camera-only, radar-only, and fused camera-radar systems) produced an estimated 46 percent reduction in the same crash type.[140] Similarly, in a 2017 study, IIHS found that vehicles equipped with FCW and AEB showed a 50 percent reduction for the same crash type.[141] NHTSA is drawing from these research studies, generally, since each has limitations and deviations from how NHTSA might evaluate fleet-wide [142] system effectiveness.

From a functional perspective, research suggests that active braking systems, such as AEB, provide greater safety benefits than corresponding warning systems, such as FCW. However, NHTSA has found that current AEB systems often integrate the functionalities of FCW and AEB into one frontal crash prevention system to deliver improved real-world safety performance and high consumer acceptance. Consequently, the Agency believes that this system integration may have implications for NCAP FCW testing because current NCAP FCW requirements were developed at a time when FCW and AEB functionalities were not always linked. As will be detailed later in this notice, NHTSA believes that FCW could now be considered a component of AEB and PAEB such that FCW operation could be evaluated using NCAP's AEB and PAEB tests.

2. Automatic Emergency Braking (AEB)

To address the rear-end crash problem further, in November 2015, NHTSA published a final decision notice announcing the addition of two AEB technologies, CIB and DBS, into NCAP effective with model year 2018 vehicles.[143]

Unlike FCW systems, AEB systems (*i.e.,* CIB and DBS), are designed to help drivers actively avoid or mitigate the severity of rear-end crashes. CIB systems provide automatic braking when forward-looking sensors indicate that a crash is imminent and the driver has not braked, whereas DBS systems provide supplemental braking when sensors determine that driver-applied braking is insufficient to avoid an imminent crash.

In Consumer Reports' 2019 subscriber survey, 81 percent of vehicle owners reported that they were satisfied with AEB technology, 54 percent said that it had helped them avoid a crash, and 61 percent stated that they trusted the system to work every time.[144] Furthermore, IIHS found in its 2017 study that rear-end collisions decreased by 50 percent for vehicles equipped with AEB and FCW.[145] Similarly, as mentioned earlier, UMTRI [146] found that AEB systems produced an estimated 46 percent reduction in applicable rear-end crashes when combined with a forward collision alert, which alone showed only a 21 percent reduction.[147]

A recent IIHS study [148] of 2009–2016 crash data from 23 States suggested that the increasing effectiveness of AEB technology in certain crash situations is changing the rear-end crash problem. The Institute's analysis provided insight into the performance of current AEB systems and future opportunities for improvement. The study identified the types of rear-end crashes in which striking vehicles equipped with AEB were over-represented compared to those without AEB.[149] For instance, IIHS found that striking vehicles involved in the following rear-end crashes were more likely to have AEB: (1) Where the striking vehicle was turning relative to when it was moving straight; (2) when the struck vehicle was turning or changing lanes relative to when it was slowing or stopped; (3) when the struck vehicle was not a passenger vehicle or was a special use vehicle relative to a passenger car; (4) on snowy or icy roads; or (5) on roads with speed limits of 112.7 kph (70 mph) relative to those with 64.4 to 72.4 kph (40 to 45 mph) speed limits. Overall, the study found that 25.3 percent of crashes where the striking vehicle was equipped with AEB had at least one of these over-represented characteristics, compared with 15.9 percent of impacts by vehicles that were not equipped with AEB.

These results suggest that the tests used to evaluate the performance of AEB systems by the Agency's NCAP and other consumer information programs are influencing the development of countermeasures capable of minimizing the crash problems that they were intended to address. However, the results also imply that AEB systems have not yet provided their full crash reduction potential. While they are effective at addressing the most common rear-end crashes, they are less effective at addressing those crashes that

---

[138] Consumer Reports (2019, August 5), *Guide to forward collision warning: How FCW helps drivers avoid accidents, https://www.consumerreports.org/car-safety/forward-collision-warning-guide/.*

[139] Leslie, A.J., Kiefer, R.J., Meitzner, M.R., & Flannagan, C.A. (2019), *Analysis of the field effectiveness of General Motors production active safety and advanced headlighting systems,* The University of Michigan Transportation Research Institute and General Motors LLC. UMTRI–2019–6.

[140] The Agency notes that the FCW effectiveness rate (21%) observed by UMTRI is similar to that observed by IIHS in its 2019 study (27%). Differences in data samples and vehicle selection may contribute to the specific numerical differences. Regardless, the AEB effectiveness rate observed by UMTRI (46%) was significantly higher than the corresponding FCW effectiveness rate observed in either the IIHS or UMTRI study.

[141] Low-speed AEB showed a 43% reduction.

[142] The UMTRI study was limited to GM vehicles.

[143] 80 FR 68604 (Nov. 5, 2015). CIB and DBS together are considered Automatic Emergency Braking (AEB).

[144] Consumer Reports, (2019, August 5), *Guide to automatic emergency braking: How AEB can put the brakes on car collisions, https://www.consumerreports.org/car-safety/automatic-emergency-braking-guide/.*

[145] Cicchino, J.B. (2017, February), Effectiveness of forward collision warning and autonomous emergency braking systems in reducing front-to-rear crash rates, *Accident Analysis and Prevention,* 2017 Feb;99(Pt A):142–152, *https://doi.org/10.1016/j.aap.2016.11.009.*

[146] Leslie, A.J., Kiefer, R.J., Meitzner, M.R., & Flannagan, C.A. (2019, September), *Analysis of the field effectiveness of General Motors production active safety and advanced headlighting systems,* The University of Michigan Transportation Research Institute and General Motors LLC, UMTRI–2019–6.

[147] The AEB systems studied by UMTRI consisted of camera-only, radar-only, and fused camera-radar AEB systems, the latter two systems of which also included adaptive cruise control functionality.

[148] Cicchino, J.B. & Zuby, D.S. (2019, August), Characteristics of rear-end crashes involving passenger vehicles with automatic emergency braking, *Traffic Injury Prevention,* 2019, VOL. 20, NO. S1, S112–S118 *https://doi.org/10.1080/15389588.2019.1576172.*

[149] In this instance, over-represented means a higher frequency as a percentage for AEB-equipped vehicles versus non-AEB-equipped vehicles on a normalized basis.

are more atypical. IIHS found that in 2016, nearly 300,000 (15 percent) of the police reported two-vehicle rear-end crashes involved one of the rear-end crashes mentioned above. The Institute suggested that vehicle manufacturers would be encouraged to improve AEB system designs for situations where AEB was over-represented if consumer programs incorporated tests that replicate these rear-end crash events, such as an angled target vehicle that simulates a struck vehicle changing lanes. IIHS cautioned (and NHTSA agrees) that new testing protocols should not drive performance degradation in more typical crash situations, create unintended safety consequences, or adversely affect AEB use due to nuisance activations.

While these recent studies suggest that AEB systems (*i.e.,* CIB and DBS) have collectively been effective in reducing rear-impact crashes, it is not clear how effective each of these systems are as standalone systems, and whether their individual effectiveness may change for certain crash scenarios, environmental conditions, or driver factors (*e.g.,* poor judgement, distraction, etc.). Furthermore, the Agency is not aware of any studies of current-generation AEB systems that have determined the extent to which CIB and DBS individually contributes to crash reduction.

Prior to considering adopting AEB into NCAP, NHTSA conducted a review of 2003–2009 National Automotive Sampling System Crashworthiness Data System (NASS CDS) data to define the target population for rear-end crashes.[150] At the time of the analysis, the Agency concluded that CIB and DBS target crash populations were mutually exclusive. In other words, they included crashes in which the driver either did not brake (CIB) or braked (DBS). The analysis of the crash data showed that the driver braked in approximately half of the crashes and did not brake in the other half. However, in its analysis of the 2011–2015 FARS and GES data sets, Volpe found much more conservative brake rates. The organization found that the driver braked in just 8 percent of rear-end crashes involving fatalities and 20 percent of those crashes involving injuries. The study also showed that the driver made no attempt to avoid the crash (*e.g.,* no braking, steering, accelerating) for 56 percent of the crashes involving fatalities and for 21 percent of those involving injuries.[151] It is possible that the brake rate differed for the two studies because of the target crash population refinements made for NHTSA's original analysis and because of difference in data collection methods between the crash databases. For instance, high-speed crashes were excluded from NHTSA's target crash population review because the AEB systems tested at the time had limited speed reduction capabilities.

From the refined target crash population, NHTSA computed preliminary safety benefits for both CIB and DBS from a limited number of CIB- and DBS-equipped vehicles subjected to early versions of the Agency's test procedures based upon speed reduction capabilities.[152] The Agency recognized that CIB and DBS systems available at the time had limited capabilities and could not address serious crashes where fatalities were likely to occur. Nevertheless, the Agency tentatively found that if a CIB system alone was equipped on all light vehicles, it could potentially prevent approximately 40,000 minor/moderate injuries (AIS 1–2), 640 serious-to-critical injuries (AIS 3–5), and save approximately 40 lives, annually. If a DBS system alone was equipped on all light vehicles, it could potentially prevent approximately 107,000 minor/moderate injuries (AIS 1–2), 2,100 serious-to-critical injuries (AIS 3–5), and save approximately 25 lives, annually. These safety benefits from CIB and DBS were considered incremental to the benefits stemming from an FCW alert.[153]

NHTSA's analysis showed there was merit to performing testing to assess vehicle performance in situations where a driver either does not brake (CIB) or brakes (DBS). Volpe's recent analysis on braking behavior/rate further validates the need to assess CIB and DBS separately. Considering this and the fact that NHTSA cannot currently differentiate the individual effectiveness of CIB and DBS systems, NHTSA tentatively believes NCAP should continue to assess CIB and DBS system performance individually. However, the Agency acknowledges that, because it believes AEB systems have advanced significantly in recent years, it is appropriate at this time to consider revising performance envelopes and dynamic scenarios in NCAP to acknowledge and encourage such advances.

The following sections discuss in detail CIB and DBS systems, and more specifically, NCAP's current test procedures and a potential updated test program for modern AEB systems. The Agency seeks comment on how NCAP can encourage the maximum safety benefits of AEB and potentially reduce the number of tests conducted. Comments are also sought on future suggestions for AEB beyond any near-term upgrade.

a. Dynamic Brake Support (DBS)

In response to an FCW alert or a driver noticing an imminent crash scenario, a driver may initiate braking to avoid a rear-end crash. In situations where the driver's braking is insufficient to prevent a collision, DBS can automatically supplement the driver's braking action to prevent or mitigate the crash. Similar to FCW and CIB systems, DBS systems employ forward-looking sensors such as radar, lidar, and/or vision-based sensors to detect vehicles in the path directly ahead and monitor a vehicle's operating conditions such as speed or brake application. However, DBS systems can actively supplement braking to assist the driver whereas FCW systems serve only to warn the driver of a potential crash threat, and CIB systems are activated when a rear-end crash is imminent, but the driver has not manually applied the vehicle's brakes.[154]

NCAP's current DBS test procedure[155] consists of the same three rear-end crash scenarios specified in the FCW system performance test procedure—LVS, LVD, and LVM, but most of the test speed combinations specified in the DBS test procedure differ (the single exception is that the FCW and DBS test procedures both use an LVM test performed with SV and POV speeds of 72.4 and 32.2 kph (45 and 20 mph), respectively). In addition,

---

[150] National Highway Traffic Safety Administration (2012, June), *Forward-looking advanced braking technologies research report, https://www.regulations.gov/document?D=NHTSA-2012-0057-0001.*

[151] The Agency notes that for the rear-end pre-crash scenario group, the driver avoidance maneuver was unknown in 25 percent and 54 percent of the FARS and GES crashes, respectively.

[152] National Highway Traffic Safety Administration (2014, August), *Automatic emergency braking system (AEB) research report, https://www.regulations.gov/document?D=NHTSA-2012-0057-0037.*

[153] FCW, CIB, and DBS combined on all light vehicles could potentially prevent approximately 200,000 minor/moderate injuries (AIS 1–2), 4,000 (AIS 3–5) serious injuries, and save approximately 100 lives annually.

[154] DBS systems differ from traditional brake assist systems used with the vehicle's foundation brakes. Whereas both systems rely on brake pedal application rate to determine whether supplemental braking is required, DBS has a lower activation threshold since it also uses information from the aforementioned sensors to verify that more braking is needed.

[155] National Highway Traffic Safety Administration (2015, October), *Dynamic brake support performance evaluation confirmation test for the New Car Assessment Program, http://www.regulations.gov,* Docket No. NHTSA–2015–0006–0026.

the DBS performance assessment includes a Steel Trench Plate (STP) false positive suppression test, which is conducted at two test speeds. This fourth test scenario is used to evaluate the propensity of a vehicle's DBS system to activate inappropriately in a non-critical driving scenario that would not present a safety risk to the vehicle's occupants. For the first three test scenarios, where braking is expected, the SV must provide enough supplemental braking to avoid contact with the POV to pass a trial run. In the case of the DBS false positive test scenario, the performance criterion is minimal to no activation for both test speeds.[156]

As in the FCW system performance tests, the vehicle that is subjected to the DBS test scenarios is the SV. The FCW test procedure (which uses professional drivers for acceleration, braking, and steering during test conduct) stipulates that a mid-size passenger car serve as the POV during testing. The DBS test procedure (which relies solely on the use of a programmable brake controller and the vehicle's DBS system for braking), however, utilizes a surrogate (*i.e.,* target vehicle) to limit the potential for damage to the SV and/or test equipment in the event of a collision.

The target vehicle presently used as the POV by NCAP for the Agency's DBS testing is known as the Subject Surrogate Vehicle, or SSV. The SSV, developed by NHTSA for the purpose of track testing, appears as a ''real'' vehicle to the camera, radar, and lidar sensors used by existing AEB systems. The SSV system is comprised of (a) a shell,[157] which is a visually and dimensionally accurate representation of a passenger car; (b) a slider and load frame assembly to which the shell is attached, (c) a two-rail track on which the slider operates, (d) a road-based lateral restraint track, and (e) a tow vehicle, which pulls the SSV and its peripherals down the test track during trials where the POV (*i.e.,* SSV) must be in motion. A brief discussion on the use of the GVT, discussed earlier in the BSI section, as an alternative to the SSV for future DBS and CIB testing, is included later in this notice.[158]

A short description of each DBS system performance test scenario, and the requirements for a passing result, is provided below:

- Lead Vehicle Stopped (LVS)—The SV encounters a stopped POV on a straight road. The SV is moving at 40.2 kph (25 mph) and the POV is stationary. The SV throttle is released within 500 ms after the SV issues an FCW alert, and the SV brake is applied at a TTC of 1.1 s (*i.e.,* at a nominal headway of 12.2 m (40 ft.)). To pass this test, the SV must not contact the POV.
- Lead Vehicle Decelerating (LVD)—The SV encounters a POV slowing with constant deceleration directly in front of it on a straight road. The SV and POV are both driven at 56.3 kph (35 mph) with an initial headway of 13.8 m (45.3 ft.). The POV brakes are then applied at a constant deceleration of 0.3g in front of the SV. The SV throttle is released within 500 ms after the SV issues an FCW alert, and the SV brakes are applied at a TTC of 1.4 s (*i.e.,* at a nominal headway of 9.6 m (31.5 ft.)). To pass this test, the SV must not contact the POV.
- Lead Vehicle Moving (LVM)—The SV encounters a slower-moving POV directly in front of it on a straight road. In the first test, the SV and POV are driven on a straight road at a constant speed of 40.2 kph (25 mph) and 16.1 kph (10 mph), respectively. In the second test, the SV and POV are driven at a constant speed of 72.4 kph (45 mph) and 32.2 kph (20 mph), respectively. In both tests, the SV throttle is released within 500 ms after the SV issues an FCW alert, and the SV brakes are applied at a TTC of 1 s (*i.e.,* at a nominal headway of 6.7 m (22 ft.) in the first test, and 11.3 m (37 ft.) in the second test). To pass these tests, the SV must not contact the POV.
- Steel Trench Plate (STP) test (to assess false positive suppression)—The SV is driven over a 2.4 m x 3.7 m x 25.4 mm (8 ft. x 12 ft. x 1 in.) steel trench plate at 40.2 kph (25 mph) and 72.4 kph (45 mph). If no FCW alert is issued by a TTC of 2.1 s, the SV throttle is released within 500 ms of a TTC of 2.1 s, and the SV brakes are applied at a TTC of 1.1 s (*i.e.,* at a nominal distance of 12.3 m (40 ft.) from the edge of the STP at 40.2 kph (25 mph), or 22.3 m (73 ft.) at 72.4 kph (45 mph)). To pass this test, the performance criteria is non-activation, as defined above.

To pass NCAP's DBS system performance criteria, the SV must currently pass five out of seven trials for each of the six test conditions.

As previously mentioned, NCAP's LVS, LVM, and LVD test scenarios for its DBS evaluations are similar to those for the FCW assessments and therefore correspond well with real-world crash data and have similar target crash populations. NHTSA's analysis of the 2011–2015 rear-end crash data from FARS and GES showed target crash populations of 65 percent for the LVS scenario, 22 percent for the LVD scenario, and 10 percent for the LVM scenario.[159] Furthermore, Volpe's independent review of the 2011–2015 data sets showed that for rear-end crashes that occurred on roadways with posted speeds of 40.2 kph (25 mph) or less, 56.3 kph (35 mph) or less, and 72.4 kph (45 mph) or less, the fatality rate was 2 percent, 11 percent, and 28 percent, respectively. Additionally, MAIS 1–5 injuries were observed in 6 percent of all rear-end crashes that occurred on roadways with posted speeds of 40.2 kph (25 mph) or less, 30 percent with posted speeds of 56.3 kph (35 mph) or less, and 63 percent with posted speeds of 72.4 kph (45 mph) or less.

b. Crash Imminent Braking (CIB)

If a driver does not take any action to brake when a rear-end crash is imminent, CIB systems utilize the same types of forward-looking sensors used in DBS systems to apply the vehicle's brakes automatically to slow or stop the vehicle. The amount of braking applied varies by manufacturer, and several systems are designed to achieve maximum vehicle deceleration just prior to impact. In reviewing model year 2017–2019 NCAP CIB test data, NHTSA observed a deceleration range of 0.31 to 1.27g during test trials that provided speed reductions capable of satisfying the CIB performance criteria for a given test condition. Unlike DBS systems, which only provide additional braking to supplement the driver's brake input, CIB systems activate when the driver has not applied the brake pedal.

The Agency's current CIB test procedure[160] is comprised of the same

---

[156] Minimal activation is defined as a peak SV deceleration attributable to DBS intervention that is less than or equal to 1.25 times the average of the deceleration recorded for the vehicle's foundation brake system alone during its approach to the steel trench plate. The 1.25 multiplier serves to provide some system flexibility, meaning a mild DBS intervention is acceptable, but one where the vehicle thinks it must respond to the STP as if it was a real vehicle is not.

[157] The shell is constructed from lightweight composite materials with favorable strength-to-weight characteristics, including carbon fiber, Kevlar®, phenolic, and Nomex honeycomb. It is also wrapped with a commercially available vinyl material to simulate paint on the body panels, rear bumper, and a tinted glass rear window. A foam bumper having a neoprene cover is attached to the rear of the SSV to reduce the peak forces realized immediately after an impact from a test vehicle occurs.

[158] If the Agency decides to assess FCW in separate tests to that for DBS and CIB, those FCW tests would also be conducted using GVT.

[159] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

[160] National Highway Traffic Safety Administration. (2015, October). *Crash imminent brake system performance evaluation for the New*

four test scenarios (LVS, LVD, LVM, and the STP false positive suppression test) and accompanying test speeds as set forth in the DBS test procedure. However, the performance criteria vary slightly. The LVM 40.2 kph/16.1 kph (25 mph/10 mph) test condition stipulates that the SV may not contact the POV. The LVS, LVD, and the LVM 72.4 kph/32.2 kph (45 mph/20 mph) test conditions permit SV-to-POV contact but require minimum reductions in the SV speed. In the case of the CIB false positive tests, the performance criterion is little-to-no activation. Similar to NCAP's DBS tests, the SSV is the POV presently used in the program's CIB testing. A short description of each test scenario and the requirements for a passing result is provided below:

- LVS—SV encounters a stopped POV on a straight road. The SV is moving at 40.2 kph (25 mph) and the POV (*i.e.,* the SSV) is stationary. The SV throttle is released within 500 ms after the SV issues an FCW alert. To pass this test, the SV speed reduction attributable to CIB intervention must be ≥15.8 kph (9.8 mph).
- LVD—The SV encounters a POV slowing with constant deceleration directly in front of it on a straight road. The SV and POV are both driven at 56.3 kph (35 mph) with an initial headway of 13.8 m (45.3 ft.). The POV then decelerates, braking at a constant deceleration of 0.3g in front of the SV, after which the SV throttle is released within 500 ms after the SV issues an FCW alert. To pass this test, the SV speed reduction attributable to CIB intervention must be ≥16.9 kph (10.5 mph).
- LVM—The SV encounters a slower-moving POV directly in front of it on a straight road. In the first test, the SV and POV are driven on a straight road at a constant speed of 40.2 kph (25 mph) and 16.1 kph (10 mph), respectively. In the second test, the SV and POV are driven at a constant speed of 72.4 kph (45 mph) and 32.2 kph (20 mph), respectively. In both tests, the SV throttle is released within 500 ms after the SV issues an FCW alert. To pass the first test, the SV must not contact the POV. To pass the second test, the SV speed reduction attributable to CIB intervention must be ≥15.8 kph (9.8 mph).
- STP test (to assess false positive suppression)—The SV is driven towards a steel trench plate at 40.2 kph (25 mph) in one test and 72.4 kph (45 mph) in the other test. If an FCW alert is issued, the SV throttle is released within 500 ms of the alert. If no FCW alert is issued, the throttle is not released until the test's validity period (the time when all test specifications and tolerances must be satisfied) has passed. To pass these tests, the SV must not achieve a peak deceleration equal to or greater than 0.5g at any time during its approach to the steel trench plate.

To pass NCAP's CIB system performance criteria, the SV must pass five out of seven trials for each of the six test conditions.

Similar to FCW and DBS, NCAP's CIB test scenarios correlate to the dynamically distinct rear-end crash data discussed earlier. The Agency's analysis of the 2011–2015 crash data showed that the LVS, LVD, and LVM scenarios represented 65 percent, 22 percent, and 10 percent, respectively, of all rear-end crashes.[161] With respect to test speed, in its independent review of 2011–2015 FARS and GES data sets, Volpe concluded that 2 percent of fatal rear-end crashes and 6 percent of all rear-end crashes occurred on roadways with posted speed limits of 40.2 kph (25 mph) or less. Eleven percent of fatal rear-end crashes and 30 percent of all rear-end crashes occurred on roads with posted speeds of 56.3 kph (35 mph) or less. For posted speeds of 72.4 kph (45 mph) or less, these statistics are 28 percent and 63 percent, respectively.

c. Current State of AEB Technology

When NHTSA's CIB test scenarios were developed, relatively few vehicles were equipped with this technology, and those that were equipped had systems with limited capabilities. Since then, fitment rates for CIB systems have increased significantly. The increased fitment was due in part to an industry voluntary commitment made in March 2016. At that time, 20 vehicle manufacturers, representing more than 99 percent of light motor vehicle sales in the U.S., voluntarily committed to install AEB systems on light motor vehicles.[162] Pursuant to this voluntary commitment, the manufacturers would make FCW and CIB standard on virtually all light-duty vehicles with a gross vehicle weight rating (GVWR) of 3,855.5 kg (8,500 pounds) or less beginning no later than September 1, 2022, and all trucks with a GVWR between 3,856.0 and 4,535.9 kg (8,501 and 10,000 pounds) beginning no later than September 1, 2025. Conforming vehicles must be equipped with (1) an AEB system that earns at least an ''advanced'' rating from IIHS in its front crash prevention track tests and (2) an FCW system that meets the performance requirements specified in two of NCAP's three FCW test scenarios.[163] The manufacturers further pledged to submit annual progress reports, which IIHS and NHTSA agreed to publish. In 2017, the first reporting year, approximately 30 percent of the fleet was equipped with CIB systems (though many of those systems were not designed to meet the voluntary commitment thresholds), whereas participating manufacturers equipped 75 percent of their fleet in 2019.[164]

While the voluntary commitment worked to increase fitment rates, the stringency included in the agreement for AEB systems is lower than that included in NCAP. The voluntary commitment included front crash prevention track tests that differed in stringency from the NCAP performance thresholds, and in number. The Agency was aware of those differences at the time, but considered the voluntary commitment to be a path toward greater fleet penetration.[165]

As fitment has increased, the sensor technology for CIB systems has also advanced significantly. For instance, in 2017, many systems were not designed to meet the voluntary commitment thresholds, whereas in 2019, most vehicles with FCW and CIB systems were able to pass all relevant NCAP test scenarios. NHTSA notes that NCAP's CIB test requirements currently require a speed reduction of at least 15.8 kph (9.8 mph) in the program's LVS test. These test requirements are more stringent than those required by the voluntary commitment, which allow a

---

Car Assessment Program. http://www.regulations.gov. Docket No. NHTSA–2015–0006–0025.

[161] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

[162] Insurance Institute for Highway Safety (2016, March 17), *U.S. DOT and IIHS announce historic commitment of 20 automakers to make automatic emergency braking standard on new vehicles, https://www.iihs.org/news/detail/u-s-dot-and-iihs-announce-historic-commitment-of-20-automakers-to-make-automatic-emergency-braking-standard-on-new-vehicles.*

[163] To achieve an advanced rating in IIHS' front crash prevention track tests, a vehicle's AEB system must show a speed reduction of at least 16.1 kph (10 mph) in either the Institute's 19.3 or 40.2 kph (12 or 25 mph) tests, or a speed reduction of 8.0 kph (5 mph) in both of these tests. *https://www.iihs.org/news/detail/u-s-dot-and-iihs-announce-historic-commitment-of-20-automakers-to-make-automatic-emergency-braking-standard-on-new-vehicles.*

[164] National Highway Traffic Safety Administration (2019, December 17), *NHTSA announces update to historic AEB commitment by 20 automakers, https://www.nhtsa.gov/press-releases/nhtsa-announces-update-historic-aeb-commitment-20-automakers.*

[165] The Agency also believes that its recommendation of AEB systems (*i.e.,* CIB and DBS) that meet NCAP performance criteria on its website since the 2018 model year has further encouraged adoption of these technologies.

vehicle to comply with the memorandum for a speed reduction of 8.0 kph (5 mph) in the IIHS 19.3 or 40.2 kph (12 and 25 mph) LVS tests.[166] For the 2021 model year, the pass rate (as reported by vehicle manufacturers) for NCAP's FCW and CIB tests for vehicles [167] equipped with these technologies and for which manufacturers submitted data was 88.8 percent and 69.5 percent, respectively.[168] Furthermore, NHTSA found that 63 percent of model year 2017 vehicles did not contact the POV in the LVS scenario during the Agency's testing, whereas 100 percent of model year 2021 vehicles did not make contact with the POV when tested.[169] As such, the Agency believes current CIB system performance far exceeds NCAP's current testing requirements, such that it is feasible to update the program's CIB test conditions to further safety improvements. Recent NHTSA research supports this assertion.

d. NHTSA's CIB Characterization Study

Similar to the fleet testing performed for PAEB, the Agency conducted a series of CIB characterization tests using a sample of MY 2020 NCAP test vehicles from various manufacturers. The goal of this testing was to quantify the performance of current CIB systems using the previously defined LVS and LVD test scenarios, but with an expanded set of input conditions. Testing was conducted in accordance with the CIB test procedure prescribed above; however, several scenarios were then repeated to assess how specific procedural changes (*i.e.,* increases in test speed and deceleration magnitude) affected CIB system performance.

- For the additional LVS tests, the Agency incrementally increased the vehicle speed for the LVS test scenario (from 40.2 to 72.4 kph (25 to 45 mph) in 8.0 kph (5 mph) increments), as shown in Table 2 below, to identify when/if the vehicle reached its operational limits and/or did not react to the POV ahead. When insufficient intervention occurred for a given vehicle, the Agency repeated the test scenario at a test speed that was 4.0 kph (2.5 mph) lower.[170] This reduced speed was used to define the system's upper capabilities for the LVS scenario.
- For the additional LVD tests, the Agency evaluated how changes made to either the vehicles' speed (72.4 kph versus 56.3 kph (45 mph versus 35 mph)) or deceleration magnitude (0.5g versus 0.3g) affected CIB performance, as shown in Table 3 below.

Details of NHTSA's CIB characterization study are provided below (with speeds given in kph (mph)):

TABLE 2—NOMINAL LVS MATRIX

SV speed, (kph/mph)	POV speed, (kph/mph)
40.2/25	0/0
48.3/30	0/0
56.3/35	0/0
64.4/40	0/0
72.4/45	0/0

TABLE 3—NOMINAL LVD MATRIX

SV speed, (kph/mph)	POV speed, (kph/mph)	Peak deceleration (g)	Minimum distance, (mft.)
56.3/35	56.3/35	0.3	13.8/45.3
56.3/35	56.3/35	0.5	13.8/45.3
72.4/45	72.4/45	0.3	13.8/45.3

No additional LVM or STP false positive assessments were conducted as part of the Agency's CIB characterization study. There were several reasons for this. First, in its review of the 2011–2015 FARS and GES rear-end crash data sets, NHTSA showed that LVS and LVD rear-end scenarios resulted in the highest number of crashes and MAIS 1–5 injuries. As shown in Table A–1, there were 1,099,868 LVS, 374,624 LVD, and 174,217 LVM crashes annually.[171] Furthermore, there were 561,842 MAIS 1–5 injuries resulting from the LVS crash scenario, 196,731 for LVD, and 97,402 for LVM. The LVS scenario also had the second highest number of fatalities. Secondly, it was unclear whether performing a set of additional STP false positive tests would provide useful data. When the STP test was initially developed, many AEB systems relied solely on radar for lead vehicle detection. Today, most vehicles utilize camera-only or fused systems that rely on both camera and radar. Although the Agency has observed instances of false positive test failures during CIB and DBS NCAP evaluations performed with radar-only systems, none have been observed when camera-only or fused systems were evaluated in the program. While some radar-only systems have had difficulty classifying the STP correctly, camera-only and fused (*i.e.,* camera plus radar) systems have not exhibited this issue.[172] For these reasons, the Agency believes it may be appropriate to remove the false positive STP assessments from NCAP's AEB evaluation matrix in this NCAP update and is seeking comment in that regard.

The Agency chose to increase the test speeds of the scenarios included in its CIB characterization study because, in its independent analysis of the 2011–2015 FARS data set, Volpe found that speeding was a factor in 42 percent of the fatal rear-end crashes.[173] A review of Volpe's analysis also showed that approximately 28 percent of fatalities and 63 percent of injuries in rear-end crashes occurred when the posted speed on roadways is 72.4 kph (45 mph) or less. When the travel speed was reported in FARS and GES, approximately 7 percent of fatal and 34 percent of the police reported real-end crashes resulting in injuries occurred at

---

[166] Insurance Institute for Highway Safety (2016, March 17), *U.S. DOT and IIHS announce historic commitment of 20 automakers to make automatic emergency braking standard on new vehicles, https://www.iihs.org/news/detail/u-s-dot-and-iihs-announce-historic-commitment-of-20-automakers-to-make-automatic-emergency-braking-standard-on-new-vehicles.*

[167] In this instance, ''vehicles'' refers to the total number of vehicles in the 2021 fleet, and not the total number of vehicle models for that year.

[168] These values assume a fifty percent take rate for vehicles having optional equipment.

[169] No contact was assumed if the test vehicle did not contact the POV in 5 or more of the 7 required trial runs.

[170] Insufficient intervention was defined as a maximum (peak) deceleration of less than 0.5g.

[171] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

[172] This is not to suggest that camera systems are superior to radar systems in all tests.

[173] Swanson, E., Foderaro, F., Yanagisawa, M., Najm, W.G., & Azeredo, P. (2019, August), *Statistics of light-vehicle pre-crash scenarios based on 2011–2015 national crash data* (Report No. DOT HS 812 745), Washington, DC: National Highway Traffic Safety Administration.

speeds of 72.4 kph (45 mph) or less.[174] These data suggested that there was merit to assessing the capabilities of newer vehicles using LVS tests performed at higher speeds since this would allow the Agency to gauge the ability of current-generation CIB systems to address a greater number of rear-end crashes, particularly those that produce the most serious and fatal injuries. The Agency also reasoned that it was most appropriate to increase the test speed in NCAP's LVS scenario, in particular, since this scenario has the potential to require the greatest speed reduction authority to realize potential safety benefits. Historically, it has also been a difficult scenario for forward-looking sensing systems to address, especially at high vehicle speeds.

Although NHTSA acknowledges that the majority of fatal rear-end crashes (72 percent) occurred on roads with posted speeds exceeding 72.4 kph (45 mph), these higher speeds were not assessed as part of the Agency's characterization testing. Prior to testing, the Agency had safety concerns with conducting LVS tests at speeds of 80.5 kph (50 mph) or more due to test track length limitations, inherent safety considerations for laboratory personnel, and potential damage to either the SV or test equipment. That said, as will be discussed later in this section, data collected during the Agency's testing showed that higher test speeds may be feasible, as several vehicles provided complete crash avoidance at 72.4 kph (45 mph).

NHTSA's intent in evaluating a modified LVD scenario was to document the performance of current-generation CIB systems using more demanding LVD-based driving situations. The Agency also planned to use these test results to determine the feasibility of increasing the stringency of NCAP's LVD test. Compared to the LVD test conditions presently specified in NHTSA's CIB test procedure, the modified LVD tests, as shown in Table 3, either (1) maintained the existing 13.8 m (45.3 ft.) SV-to-POV headway and 0.3g POV deceleration profile, but increased the travel speed of both the POV and SV from 56.3 to 72.4 kph (35 to 45 mph), or (2) maintained the existing 13.8 m (45.3 ft.) SV-to-POV headway and existing 56.3 kph (35 mph) POV and SV speeds, but increased the average POV deceleration magnitude to 0.5g.

NHTSA's interest in the first LVD procedural change aligned with that mentioned for the LVS scenario changes—a significant number of injuries and fatalities in rear-end crashes occurred at higher speeds. The second change was made to address situations where the driver of a lead vehicle brakes aggressively, causing the driver of the following vehicle to have even less time to avoid or mitigate the crash than had the lead vehicle braking been at the 0.3g level presently specified. The Agency reasoned that implementing these changes for the LVD scenario would introduce a more stringent scenario than that which is currently prescribed in NHTSA's CIB test procedure, and would thus help the Agency understand the capabilities of current CIB systems more comprehensively.

Test reports related to NHTSA's CIB characterization testing can be found in the docket for this notice.

e. Updates to NCAP's CIB Testing

In general, this study has allowed NHTSA to assess the performance of current CIB systems and evaluate the technology's future potential for the new model years' vehicle fleet. The study showed that many vehicles in today's fleet were able to repeatedly provide complete crash avoidance at higher test speeds, shorter SV-to-POV headways, and generally more aggressive conditions than those specified in the Agency's current NCAP CIB test procedure. This study has also provided the Agency with new ways to consider differentiating CIB systems' performance for NCAP ratings purposes in the future. Furthermore, it has provided the Agency with the underlying support necessary for NCAP to propose adjustments to the current CIB performance requirements to address rear-end crashes that are causing a greater number of injuries and fatalities in the real world. Accordingly, the Agency is proposing to make several changes to its CIB test procedure for this NCAP upgrade. These changes are outlined below for each test scenario. For the LVS scenario, the Agency is proposing the following:

- Increased SV test speeds and an assessment methodology that is similar to that which it proposed to assess PAEB system performance. CIB system performance for the LVS scenario will be assessed over a range of test speeds. The Agency is proposing a minimum SV test speed of 40 kph (24.9 mph), which is similar to that currently specified in NHTSA's CIB test procedure—40.2 kph (25 mph), and a maximum SV test speed of 80.0 kph (49.7 mph). The Agency is proposing to increase the subject vehicle test speed in 10 kph (6.2 mph) increments from the minimum test speed to the maximum test speed for the LVS assessment.

The Agency's characterization testing showed that it is feasible to raise the SV speed in NCAP's LVS test to encourage improved performance of CIB systems. In fact, several vehicles repeatably afforded full crash avoidance (*i.e.,* no contact) at speeds up to 72.4 kph (45 mph) for the LVS test scenario. Furthermore, NHTSA recognizes that Euro NCAP performs its Car-to-Car Rear stationary (CCRs) scenario, which is comparable to the Agency's LVS tests, at speeds as high as 80 kph (49.7 mph) for those systems that offer AEB, which also suggests that higher test speeds are practicable.[175] As such, NHTSA believes that it is appropriate to harmonize with Euro NCAP on the maximum LVS test speed of 80 kph (49.7 mph), as this should better address the higher severity, high-speed crash problem and, in turn, further reduce fatalities and serious injuries. Although Euro NCAP's protocol prescribes a minimum SV test speed of 10 kph (6.2 mph) for the CCRs scenario for AEB systems that also offer FCW, the Agency does not see a reason to perform its LVS test at a speed that is less than that which is specified in its existing test procedure (40.2 kph (25 mph)). Therefore, it is not proposing to harmonize with Euro NCAP with respect to the minimum required test speed.

- A revised performance requirement. In lieu of a speed reduction, as is currently specified in NHTSA's CIB test procedure for the LVS scenario, the SV must avoid making contact with the POV target to pass a test trial. Similar to PAEB, this should limit damage to the SV and POV target during testing and reduce chances that results are questioned or invalidated.
- Changes to the number of test trials required for the LVS scenario. Currently, NHTSA's CIB test procedure requires that a vehicle meet the performance criteria (*i.e.,* specified speed reduction) for five out of seven trials. However, similar to that proposed by NHTSA for its PAEB assessment, the Agency is proposing that only one test trial will be conducted per test speed assessed (*i.e.,* 40, 50, 60, 70, and 80 kph or 24.9, 31.1, 37.3, 43.5, and 49.7 mph) if the SV does not contact the POV target during the first valid trial for each of the test speeds. For a given test condition, the test sequence is initiated at the 40 kph (24.9 mph) minimum

---

[174] For this crash mode, 62 and 67 percent of the travel speed data is not reported in FARS and GES, respectively.

[175] European New Car Assessment Programme (Euro NCAP) (April 2021), *Test Protocol—AEB Car-to-Car systems, Version 3.0.3.* See section 8.2.3.

speed. To achieve a passing result, the test must be valid (*i.e.,* all test specifications and tolerances satisfied), and the SV must not contact the POV. If the SV does not contact the POV during the first valid test, the test speed is incrementally increased by 10 kph (6.2 mph), and the next test in the sequence is performed. Unless the SV contacts the POV, this iterative process continues until a maximum test speed of 80 kph (31.1 mph) is evaluated. If the SV contacts the POV, and the relative longitudinal velocity between the SV and POV is less than or equal to 50 percent of the initial speed of the SV, the Agency will perform four additional (repeated) test trials at the same speed for which the impact occurred. The SV must not contact the POV for at least three out of the five test trials performed at that same speed to pass that specific combination of test condition and test speed.[176] If the SV contacts the POV during a valid test of a test condition (whether it be the first test performed for a particular test speed or a subsequent test trial at that same speed), and the relative impact velocity exceeds 50 percent of the initial speed of the SV, no additional test trials will be conducted at the given test speed and test condition and the SV is considered to have failed the test condition at that specific test speed.

The Agency is pursuing an assessment approach for the LVS CIB test scenario that is similar to that proposed for PAEB systems in order to reduce test burden, given that additional test speeds are being proposed. NHTSA believes that this alternative approach will continue to ensure that passing CIB systems represent robust designs that will offer a higher level of performance and safety.

For the LVD scenario, the Agency is proposing the following:

- A reduction in SV and POV test speeds. NHTSA's CIB test procedure currently prescribes a test speed of 56 kph (34.8 mph) for the SV and POV in the LVD scenario. Euro NCAP's AEB Car-to-Car systems test protocol, Version 3.0.3, dated April 2021 for the Car-to-Car rear braking (CCRb) specifies an SV speed of 50 kph (31.1 mph). For this upgrade of NCAP, the Agency is proposing to reduce the test speed for the SV and POV to 50 kph (31.1 mph) to harmonize with Euro NCAP.[177] Given additional changes proposed for the SV-to-POV headway and deceleration magnitude (discussed next), NHTSA does not believe the proposed reduction in test speed will lead to an overall reduction in test stringency or loss of safety benefits.

The Agency is also requesting comment on whether it is appropriate to incorporate additional SV test speeds for the LVD test scenario, specifically 60, 70, and 80 kph (37.3, 43.5, and 49.7 mph) or, alternatively, whether testing at only 50 kph (31.1 mph) and 80 kph (49.7 mph) would be sufficient. As mentioned earlier, Volpe's analysis of the 2011–2015 FARS data set showed that the majority of crashes occurred on roads with posted speeds exceeding 72.4 kph (45 mph), suggesting that testing at higher speeds for all CIB test scenarios may be warranted. The Agency has simply not performed testing at 80 kph (49.7 mph) to date because of concerns surrounding laboratories' abilities to safely execute such tests and limited available testing real estate, as this test scenario requires that both the SV and POV be travelling at the same speed at the onset of the test validity period. That being said, NHTSA believes that, (1) given the results from its characterization study, and in particular, the braking performance demonstrated in the LVS tests, (2) the fact that tested vehicles may have higher POV classification confidence for the LVD test compared to the LVS test since the POV is always in motion during the LVD test, and (3) the POV will be the GVT, which relies on a robotic platform for movement, rather than the SSV which must be towed along a monorail secured to the test track, vehicles in the current fleet will likely also perform well in higher speed LVD tests. To validate this assumption, NHTSA will be conducting research next year to assess vehicle performance at speeds ranging from 50 kph (31.1 mph) to 80 kph (49.7 mph) for 12 and 40 m (39.4 and 131.2 ft.) headways and POV deceleration magnitudes of 0.4 and 0.5 g for the LVD CIB test scenario. Pending the outcome of that research, the Agency may consider adopting additional higher tests speeds (*i.e.,* 60, 70, and/or 80 kph (37.3, 43.5, and/or 49.7 mph)) for the LVD test scenario in NCAP. The Agency requests comment on what SV-to-POV headway and deceleration magnitude(s) would be appropriate if the Agency was to adopt any or all of these additional test speeds. If additional test speeds are adopted, the Agency would implement an assessment methodology similar to that proposed for the CIB LVS test scenario, whereby NHTSA would increase the SV test speed in 10 kph (6.2 mph) increments from the minimum test speed to the maximum test speed for the LVD assessment.

- A reduction in SV-to-POV headway. NHTSA's CIB test procedure currently specifies a 13.8 m (45.3 ft.) SV-to-POV headway for the LVD scenario. The Agency is proposing to reduce the prescribed headway to 12 m (39.4 ft.) to harmonize with Euro NCAP's CCRb scenario. Given the proposed test speed reduction, the Agency believes it is appropriate to also reduce the headway to maintain similar stringency with its current LVD test condition. Whereas Euro NCAP also specifies an additional SV-to-POV headway of 40 m (131.2 ft.), the Agency is not proposing to conduct this additional assessment as part of this proposal. NHTSA does not believe there would be a safety benefit to adopting 40 m (131.2 ft.) as an additional, and less stringent, headway. Therefore, it would serve to increase the test burden unnecessarily.
- An increase in deceleration magnitude. The Agency is proposing to increase the POV deceleration magnitude currently specified in its CIB test procedure for the LVD scenario from 0.3 g to 0.5 g. In the Agency's CIB characterization study, some vehicles repeatably afforded full crash avoidance (*i.e.,* no contact) for all trials when the POV executed a 0.5 g braking maneuver in the LVD condition with a SV test speed of 35 mph and SV-to-POV headway of 13.8 m (45.3 ft.). Although the test speed used in the Agency's study was slightly lower than that which the Agency is proposing for the LVD test condition, and the SV-to-POV headway was slightly longer, NHTSA believes that it is reasonable to adopt a higher POV deceleration magnitude for its future LVD testing. The Agency notes that a deceleration of 0.5 g falls within the range of deceleration magnitudes prescribed by Euro NCAP in its AEB Car-to-Car systems test protocol, Version 3.0.3, dated April 2021 for the CCRb scenario. In its CCRb test, Euro NCAP specifies POV deceleration magnitudes of 2 m/s^2 and 6 m/s^2 (approximately 0.2 to 0.6 g) for an SV-to-POV headway of 12 m (39.4 ft.) and SV test speed of 50 kph (31.1 mph). As the Agency has proposed this reduced headway and test speed for its LVD testing, it reasons that adopting a 0.5 g POV deceleration magnitude is also practicable. The Agency is not proposing 0.6 g as the POV deceleration magnitude in its LVD

---

[176] The Agency notes that a similar pass/fail criterion (*i.e.,* a vehicle must meet performance requirements for three out of five trials for a particular test condition to pass the test condition) is included in its LDW test procedure, as referenced earlier.

[177] European New Car Assessment Programme (Euro NCAP) (April 2021), *Test Protocol—AEB Car-to-Car systems, Version 3.0.3.* See section 8.2.5.

test because it has observed instances where the tires on the POV target developed flat spots during research testing conducted with the Guided Soft Target (GST) system[178] to assess Traffic Jam Assist (TJA) systems. The TJA testing required a braking maneuver for the lead vehicle decelerates, accelerates, then decelerates (LVDAD) scenario that is similar to that specified in the Agency's CIB LVD test.[179] During this testing, NHTSA also found that it was more difficult to achieve and accurately control deceleration when braking maneuvers higher than 0.5 g were used.[180] Extensive tuning efforts related to the GST brake applications were made in an attempt to rectify the problems encountered, but these adjustments were unable to consistently satisfy the test tolerances associated with 0.6 g POV deceleration for the LVDAD test and a recommendation was made to reduce the maximum nominal POV deceleration from 0.6 g to 0.5 g for future testing. In its report findings, the Agency also noted that a deceleration of 0.6 g is not only very close to the maximum braking capability of the GST's robotic platform used by the Agency, it is also very close to the default magnitude used by the LPRV during an emergency stop (maximum deceleration). As such, the Agency concluded that a decrease in maximum POV deceleration should also reduce equipment wear, particularly for the system's tires and braking components, thus improving test efficiency. This being said, the Agency acknowledges that newer robotic platforms designed to provide greater capabilities, are now becoming available, which may resolve the issues observed in the Agency's TJA testing. As such, the Agency is requesting comment on whether it is feasible to adopt a POV deceleration magnitude of 0.6 g in lieu of 0.5 g, as proposed.

- An alternative performance criterion. In lieu of a speed reduction, as is currently specified in NHTSA's CIB test procedure for the LVD scenario, the vehicle must avoid making contact with the POV target to pass a test trial.
- Changes to the number of test trials required for the LVD scenario. NHTSA is adopting an approach to conducting test trials that is identical to that described above for the CIB LVS scenario, regardless of the number of test speeds adopted (*i.e.,* one speed, 50 kph (31.1 mph); two speeds, 50 kph (31.1 mph) and 80 kph (49.7 mph); or four speeds, 50, 60, 70, and 80 kph (31.1, 37.3, 43.5, and 49.7 mph)). If only one or two test speeds are selected for inclusion, the Agency is seeking comment on whether it is more appropriate to alternatively require 7 trials for each test speed, and require that 5 out of the 7 trials conducted pass the ''no contact'' performance criterion.

For the LVM scenario, the Agency is proposing the following:

- Increased SV test speeds. NHTSA is proposing to assess CIB system performance for the LVM scenario over a range of test speeds, similar to that proposed for the LVS scenario. The Agency is proposing a minimum SV test speed of 40 kph (24.9 mph), which is nearly equivalent to the 40.2 kph (25 mph) test speed currently specified in NHTSA's CIB test procedure, and a maximum SV test speed of 80 kph (49.7 mph), which is slightly higher than the 72.4 kph (45 mph) specified for the second LVM test condition in NHTSA's current CIB test procedure. The Agency is proposing to increase the SV test speed in 10 kph (6.2 mph) increments from the minimum test speed to the maximum test speed for the LVM assessment.

The Agency did not perform additional LVM testing as part of its CIB characterization study. Nonetheless, NHTSA believes that it is feasible to raise the SV speed in NCAP's LVM test to encourage improved performance of CIB systems, as the Agency's current CIB LVM tests (conducted with an SV speed of 72.4 kph (45 mph) and POV speed of 32.2 kph (20 mph)) have shown that many vehicles are able to stop without contacting the POV target for each of the required test trials. Furthermore, NHTSA recognizes that Euro NCAP performs its Car-to-Car Rear moving (CCRm) scenario, which is comparable to the Agency's LVM tests, at speeds as high as 80 kph (49.7 mph), which also suggests that higher SV test speeds are practicable.[181] As such, NHTSA believes that it is appropriate to harmonize with Euro NCAP on the maximum SV test speed of 80 kph (49.7 mph) in the Agency's LVM test, as this should also address high-speed crashes and thus further reduce fatalities and serious injuries. Although Euro NCAP's protocol prescribes a minimum SV test speed of 30 kph (18.6 mph) for the CCRm scenario for vehicles that have AEB systems,[182] the Agency does not see a reason to perform its LVM test at a speed that is less than that which is specified in its existing test procedure (40.2 kph (25 mph)). Therefore, it is not proposing to harmonize with Euro NCAP with respect to the minimum required test speed.

- An alternative POV test speed for all test conditions. While the Agency's CIB test procedure currently specifies a POV test speed of 16.1 kph (10 mph) when the SV speed is 40.2 kph (25 mph) and a POV test speed of 32.2 kph (20 mph) when the SV speed is 72.4 kph (45 mph), the Agency is proposing to use a POV test speed of 20 kph (12.4 mph) for every SV test speed that will be assessed for the LVM scenario; 40 to 80 kph (24.9 to 49.7 mph), increased in 10.0 kph (6.2 mph) increments. NHTSA recognizes that Euro NCAP's CCRm protocol specifies a POV test speed of 20 kph (12.4 mph), and this POV speed is stipulated for similar testing conducted by various other vehicle safety ratings programs. With this proposed NCAP upgrade, NHTSA sees no reason to deviate from the other testing organizations with respect to the POV speed for its LVM test.
- A performance criterion of ''no contact''. In lieu of a speed reduction, as is currently specified in NHTSA's CIB test procedure for the Agency's higher speed LVM scenario (*i.e.,* POV of 72.4 kph (45 mph) and POV speed of 32.2 kph (20 mph)), the SV must avoid making contact with the POV target to pass a test trial for each test speed assessed for the LVM scenario; 40 to 80 kph (24.9 to 49.7 mph), increased in 10 kph (6.2 mph) increments.
- Changes to the number of test trials required for the LVM scenario. NHTSA is adopting an approach to conducting test trials that is identical to that described above for the CIB LVS scenario. For the proposed CIB LVM tests, the Agency would require one test trial per SV speed increment, and four repeat trials in the event of a test failure for instances where the SV has a relative velocity at impact that is equal to or less than 50 percent of the initial speed.

NHTSA has chosen to harmonize with Euro NCAP in many respects since it

---

[178] The GST system is comprised of two main parts—a low profile robotic vehicle (LPRV), and a global vehicle target (GVT), which is secured to the top of the LPRV.

[179] Fogle, E.E., Arquette, T.E. (TRC), and Forkenbrock, G.J. (NHTSA), (2021, May), *Traffic Jam Assist Draft Test Procedure Performability Validation* (Report No. DOT HS 812 987), Washington, DC: National Highway Traffic Safety Administration.

[180] From Section 4.1 of DOT HS 812 987—''POV deceleration validity check failures occurred during six trials of the eight LVDAD trials performed. Four of the seven 0.6 g failures were because the POV was unable to achieve the minimum deceleration threshold of 0.55 g. The remaining three 0.6 g failures were because the POV was unable to maintain a minimum average deceleration of at least 0.55 g.''

[181] European New Car Assessment Programme (Euro NCAP) (April 2021), *Test Protocol—AEB Car-to-Car systems, Version 3.0.3.* See section 8.2.3.

[182] The Agency notes that the minimum SV test for vehicles equipped with only FCW (and no AEB) is 50 kph (31.1 mph).

recognizes that the rear-end crash problem, as defined by the most frequently occurring and dynamically distinct pre-crash scenarios, could be changing as AEB-equipped vehicles become more prolific in the fleet. Accordingly, the Agency believes that it is beneficial to standardize the current CIB test specifications with other consumer information programs and focus resources on emerging trends.[183] However, the Agency also notes that it will consider making additional updates to its CIB test evaluation as the crash problem evolves.

f. Updates to NCAP's DBS Testing

NHTSA did not conduct any testing, as part of its characterization study, to evaluate DBS system performance capabilities beyond what is currently stipulated in NCAP's DBS test procedure. However, the Agency notes that its CIB and DBS test procedures are currently aligned with respect to test scenarios, test speeds, headways, etc. Differences exist only with respect to the use of an SV manual brake application (*i.e.,* for DBS) and most performance criterion. NHTSA's DBS test procedure currently specifies ''no contact'' as the performance criterion for all DBS test conditions, whereas the Agency's CIB test procedure currently requires a specified speed reduction for each of the CIB test conditions (with the exception of the lower speed LVM condition where the POV speed is 16.1 kph (10 mph) and the SV speed is 40.2 kph (25 mph), which requires ''no contact''). Therefore, NHTSA believes it is reasonable to adopt the CIB test conditions (*i.e.,* test speeds, headways, etc.) for the comparable DBS test conditions. However, given the Agency's proposal to embrace the more stringent ''no contact'' performance criterion for each of the CIB test conditions, and for the additional reasons mentioned previously, the Agency also believes, as suggested prior, that there may be merit to removing the DBS test conditions from NCAP entirely to reduce test burden and the associated cost.

In its comments to the NCAP's December 2015 notice, the Alliance[184] stated that since crash avoidance (*i.e.,* no vehicle contact) is the desired outcome for all imminent rear-end crash events, if an SV avoids contact with the POV in all CIB tests, DBS testing should not be necessary. Although NHTSA agrees with the Alliance's rationale in principle, the Agency also believes there is merit to ensuring that both AEB systems perform as designed and help the driver to mitigate or prevent the crash. The Agency reasons that it is possible for the driver to apply the brakes, but with a magnitude that does not result in achieving the vehicle's maximum crash avoidance potential (*i.e.,* deceleration). In the past, some manufacturers assumed the driver was in control when the brake pedal was depressed and would not override the driver's input when necessary to avoid a crash. Accordingly, NHTSA hesitates to assume that if CIB systems work effectively during testing, then DBS systems will automatically do so as well.

In light of these considerations, the Agency is tentatively proposing to retain both CIB and DBS system performance tests in NCAP, and to align all test conditions for comparable test scenarios (*e.g.,* SV and POV test speeds, headway, etc.) to evaluate whether the DBS system will provide supplemental braking if the driver brakes but additional braking is warranted. For this testing, the Agency is proposing to adopt an assessment approach for DBS that is identical to that described previously for PAEB and CIB. The Agency would require one test trial per speed for each test scenario, and four repeated trials for any specific test condition and speed combination that results in a test failure and where the SV has a relative velocity at impact that is equal to or less than 50 percent of the initial speed. Speeds will be increased in 10 kph (6.2 mph) increments from the minimum test speed to the maximum test speed. However, the Agency is also requesting comment on whether removal of the DBS test scenarios from NCAP would be more appropriate.

As an alternative to retaining all DBS tests in NCAP, or removing the DBS performance evaluations from NCAP entirely, the Agency believes it may be more reasonable to conduct only the LVS and LVM tests at the highest two test speeds proposed for CIB—70 and 80 kph (43.5 and 49.7 mph)—to ensure system functionality and that the SV will not suppress AEB operation when the driver applies the vehicle's foundation brakes. The Agency would also consider conducting the LVD DBS test at 70 and 80 kph (43.5 and 49.7 mph) if the Agency decides to also adopt these test speeds for the related CIB test. Comments are requested on this alternative proposal and whether an alternative assessment method would be more appropriate if any or all of the DBS test scenarios were conducted only at the two highest test speeds. For a more limited speed assessment of the two highest test speeds, 70 and 80 kph (43.5 and 49.7 mph), instead of up to four test speeds (50, 60, 70, and 80 kph (31.1, 37.3, 43.5, and 49.7 mph)) for LVD, or five test speeds (40, 50, 60, 70, and 80 kph (24.9, 31.1, 37.3, 43.5, and 49.7 mph)) for LVS and LVM), should the Agency require one trial per test condition (*i.e.,* align with the assessment method outlined for the other AEB test conditions) or multiple trials? If multiple trials were to be required, how many would be appropriate, and what would be an acceptable pass rate?

If the Agency continues to perform DBS testing in NCAP, it also proposes to revise when the manual (robotic) brake application is initiated. The current DBS test procedure prescribes this shall occur at specific TTCs per test scenario: 1.1 seconds (LVS), 1.0 seconds (LVM), and 1.4 second (LVD). The proposed revision would initiate manual braking at a time that corresponds to 1.0 second after the FCW alert is issued for all DBS test scenario and speed combinations, regardless of whether a CIB activation occurs after the FCW alert but before initiation of the manual brake application. The Agency reasons that this change is more representative of real-world use and driving conditions, and is in basic agreement with the approach specified for FCW performance evaluations in Euro NCAP's AEB Car-to-Car systems test protocol.[185] Alternatively, the Agency requests comment on appropriate TTCs for the modified test conditions.

g. Updates to NCAP's FCW Testing

As mentioned earlier, NHTSA is proposing to consolidate its FCW and CIB tests such that the CIB tests will be used as an indicant of FCW operation. The Agency is also proposing to similarly assess FCW in the context of its PAEB tests. NHTSA believes there is merit to assessing the presence of an FCW alert within the CIB and PAEB test because operation of FCW and AEB/PAEB systems, in the test scenarios to be used by NCAP, are complementary

---

[183] Cicchino, J.B. & Zuby, D.S. (2019, August), Characteristics of rear-end crashes involving passenger vehicles with automatic emergency braking, *Traffic Injury Prevention,* 2019, VOL. 20, NO. S1, S112–S118, *https://doi.org/10.1080/15389588.2019.1576172.*

[184] The Agency notes that the Alliance of Automobile Manufacturers (The Alliance) merged with Global Automakers in January 2020 to create the Alliance for Automotive Innovation (Auto Innovators). Both automotive industry groups separately submitted comments to the December 2015 notice.

[185] European New Car Assessment Programme (Euro NCAP) (April 2021), *Test Protocol—AEB Car-to-Car systems, Version 3.0.3.* See Annex A.

and fundamentally intertwined. Also, combining the Agency's FCW tests with those used to assess AEB system performance would reduce test burden. The Agency proposes that it would evaluate the presence of a vehicle's FCW system during its CIB tests by requiring the SV accelerator pedal be fully released within 500 ms after the FCW alert is issued. If no FCW alert is issued during a CIB test, the SV accelerator pedal will be fully released within 500 ms after the onset of CIB system braking.[186] Here, the onset of CIB activation is taken to be the instant SV deceleration reaches at least 0.5g. If no FCW alert is issued and the vehicle's CIB system does not offer any braking, release of the SV accelerator pedal will not be required prior to impact with the POV. The Agency is also proposing to make similar procedural changes to its PAEB test procedure. NHTSA is seeking comment as to whether the proposed FCW assessment method is reasonable. Furthermore, given that most FCW systems are currently able to pass all relevant NCAP test scenarios, as mentioned earlier, the Agency believes that, as an alternative to integrating the assessment of FCW into the Agency's CIB tests, it may be feasible for NCAP to perform one FCW test that could serve as an indicant of FCW system performance (while still retaining the previously-stated accelerator pedal release timing to ensure CIB activation is not unintentionally suppressed). This would also reduce test burden. If the Agency were to choose one of the proposed CIB test scenarios to adopt for an FCW test to assess the performance of FCW systems, which CIB test scenario do commenters believe would be most appropriate and why?

The Agency notes that if it maintains any or all of the FCW test scenarios that are currently included in its FCW test procedure, it proposes to align the corresponding maximum SV test speeds, POV speeds, headway, POV deceleration magnitude, etc., as applicable, with the included CIB tests, similar to that which it has proposed for the DBS tests. Accordingly, the Agency would adopt the following for the FCW tests:

- LVS—SV speed of 80 kph (49.7 mph); POV is stationary.
- LVD—SV and POV speed of 50 kph (31.1 mph) or up to 80 kph (49.7 mph), depending on the final test speed adopted for the CIB LVD scenario; a 12 m (39.4 ft.) SV-to-POV headway; and a POV deceleration magnitude of 0.5 g.
- LVM—SV speed of 80 kph (49.7 mph); POV speed of 20 kph (12.4 mph).

If the Agency continues to conduct separate FCW assessments, it will need to revise the prescribed TTCs currently used to assess FCW performance to align with the revised test scenario and speed combinations.[187] Given the Agency's thoughts about FCW–AEB integration and the revised test conditions that would be adopted for any future FCW tests, NHTSA requests comment on what TTC would be appropriate for each test scenario. Although the Agency is proposing to adopt an assessment approach for FCW that is identical to that described previously for PAEB, CIB, and DBS,[188] it is also requesting comment on whether an alternative assessment method would be appropriate in instances where it retains one or more FCW scenarios that are performed at a single test speed. In such instances, should the Agency require one trial per test condition (*i.e.,* align with the assessment method outlined for the other AEB test conditions) or multiple trials? If multiple trials were to be required, how many would be appropriate, and what would be an acceptable pass rate?

h. Regenerative Braking

In addition to the FCW alert setting, discussed earlier, there are additional system settings that the Agency must now consider during its AEB and PAEB testing. One such setting is that for regenerative braking. Regenerative braking, which has become more common as electric vehicles have begun to proliferate the fleet, can slow the vehicle when the throttle is released. As such, when the throttle is fully released upon the issuance of the FCW alert in the Agency's AEB and PAEB testing, vehicle speed can reduce significantly prior to the onset of braking associated with these technologies, particularly in instances where the FCW alert is issued early. For vehicles with regenerative braking that have multiple settings (*e.g.,* nominal, more aggressive, less aggressive), the Agency is proposing to use the ''off'' setting or the setting that provides the lowest deceleration when the accelerator is fully released in its AEB and PAEB tests.[189] Although NHTSA reasons that the nominal setting may be the setting most commonly chosen by a typical driver, it prefers the least aggressive setting, as it would be more indicative of ''worst case''. Selecting a setting that affords the lowest deceleration allows the vehicle to travel faster at the onset of braking associated with AEB and PAEB. This approach would produce a situation that is more comparable to that for vehicles that do not have regenerative braking.

The Agency believes that regenerative braking may also introduce complications for the Agency's DBS tests (if the DBS tests are retained in NCAP). NHTSA reasons that some vehicles may offer regenerative braking that is already so high that there would be only a relatively small boost in braking from the braking actuator (acting to provide a combined 0.4 g deceleration). For instance, if the regenerative braking from simply releasing the accelerator pedal results in 0.3 g braking, the additional braking required to get to 0.4 g from the actuator would be a very low force and/or brake pedal displacement. The Agency is requesting comment on whether regenerative braking may introduce additional testing issues and on any recommendations for test procedural changes to rectify possible testing issues related to regenerative braking.

With respect to FCW, CIB, and DBS testing in NCAP, NHTSA is seeking comment on the following:

(38) For the Agency's FCW tests:

—If the Agency retains one or more separate tests for FCW, should it award credit solely to vehicles equipped with FCW systems that provide a passing audible alert? Or, should it also consider awarding credit to vehicles equipped with FCW systems that provide passing haptic alerts? Are there certain haptic alert types that should be excluded from consideration (if the Agency was to award credit to vehicles with haptic alerts that pass NCAP tests) because they may be a nuisance to drivers such that they are more likely to disable the system? Do commenters

---

[186] Previous NHTSA research indicates that human drivers are capable of releasing the accelerator pedal within 500 ms after returning their eyes to a forward-facing viewing position in response to an FCW alert. Forkenbrock, G., Snyder, A., Hoover, R., O'Harra, B., Vasko, S., Smith, L. (2011, July), *A Test Track Protocol for Assessing Forward Collision Warning Driver-Vehicle Interface Effectiveness* (Report No. DOT HS 811 501), Washington, DC: National Highway Traffic Safety Administration.

[187] To pass a test trial, the vehicle must issue the FCW alert on or prior to the prescribed time-to-collision (TTC) specified for each of the three FCW test scenarios.

[188] In essence, the Agency would require one test trial per speed for each test scenario and four repeat trials in the event of a test failure for instances where the SV has a relative velocity at impact that is equal to or less than 50 percent of the initial speed. Speeds will be increased in 10 kph (6.2 mph) increments from the minimum test speed to the maximum test speed.

[189] The Agency does not plan to make any procedural modifications for vehicles that have regenerative braking that cannot be switched off or adjusted, as those vehicles should operate similarly in the real world.

believe that haptic alerts can be accurately and objectively assessed? Why or why not? Is it appropriate for the Agency to refrain from awarding credit to FCW systems that provide only a passing visual alert? Why or why not? If the Agency assesses the sufficiency of the FCW alert in the context of CIB (and PAEB) tests, what type of FCW alert(s) would be acceptable for use in defining the timing of the release of the SV accelerator pedal, and why?

—Is it most appropriate to test the middle (or next latest) FCW system setting in lieu of the default setting when performing FCW and AEB (including PAEB) NCAP tests on vehicles that offer multiple FCW timing adjustment settings? Why or why not? If not, what use setting would be most appropriate?

—Should the Agency consider consolidating FCW and CIB testing such that NCAP's CIB test scenarios would serve as an indicant of FCW operation? Why or why not? The Agency has proposed that if it combines the two tests, it would evaluate the presence of a vehicle's FCW system during its CIB tests by requiring the SV accelerator pedal be fully released within 500 ms after the FCW alert is issued. If no FCW alert is issued during a CIB test, the SV accelerator pedal will be fully released within 500 ms after the onset of CIB system braking (as defined by the instant SV deceleration reaches at least 0.5g). If no FCW alert is issued and the vehicle's CIB system does not offer any braking, release of the SV accelerator pedal will not be required prior to impact with the POV. The Agency notes that it has also proposed these test procedural changes for its PAEB tests as well. Is this assessment method for FCW operation reasonable? Why or why not?

—If the Agency continues to assess FCW systems separately from CIB, how should the current FCW performance criteria (*i.e.,* TTCs) be amended if the Agency aligns the corresponding maximum SV test speeds, POV speeds, SV-to-POV headway, POV deceleration magnitude, etc., as applicable, with the proposed CIB tests, and why? What assessment method should be used—one trial per scenario, or multiple trials, and why? If multiple trials should be required, how many would be appropriate, and why? Also, what would be an acceptable pass rate, and why?

—Is it desirable for NCAP to perform one FCW test scenario (instead of the three that are currently included in NCAP's FCW test procedure), conducted at the corresponding maximum SV test speed, POV speed, SV-to-POV headway (as applicable), POV deceleration magnitude, etc. of the proposed CIB test to serve as an indicant of FCW system performance? If so, which test scenario from NCAP's FCW test procedure is appropriate?

—Are there additional or alternative test scenarios or test conditions that the Agency should consider incorporating into the FCW test procedure, such as those at even higher test speeds than those proposed for the CIB tests, or those having increased complexity? If so, should the current FCW performance criteria (*i.e.,* TTCs) and/or test scenario specifications be amended, and to what extent?

(39) For the Agency's CIB tests:

—Are the SV and POV speeds, SV-to-POV headway, deceleration magnitude, etc. the Agency has proposed for NCAP's CIB tests appropriate? Why or why not? If not, what speeds, headway(s), deceleration magnitude(s) are appropriate, and why? Should the Agency adopt a POV deceleration magnitude of 0.6 g for its LVD CIB test in lieu of 0.5 g proposed? Why or why not?

—Should the Agency consider adopting additional higher tests speeds (*i.e.,* 60, 70, and/or 80 kph (37.3, 43.5, and/or 49.7 mph)) for the CIB (and potentially DBS) LVD test scenario in NCAP? Why or why not? If additional speeds are included, what headway and deceleration magnitude would be appropriate for each additional test speed, and why?

—Is a performance criterion of ''no contact'' appropriate for the proposed CIB and DBS test conditions? Why or why not? Alternatively, should the Agency require minimum speed reductions or specify a maximum allowable SV-to-POV impact speed for any or all of the proposed test conditions (*i.e.,* test scenario and test speed combination)? If yes, why, and for which test conditions? For those test conditions, what speed reductions would be appropriate? Alternatively, what maximum allowable impact speed would be appropriate?

(40) For the Agency's DBS tests:

—Should the Agency remove the DBS test scenarios from NCAP? Why or why not? Alternatively, should the Agency conduct the DBS LVS and LVM tests at only the highest test speeds proposed for CIB—70 and 80 kph (43.5 and 49.7 mph)? Why or why not? If the Agency also adopted these higher tests speeds (70 and 80 kph (43.5 and 49.7 mph)) for the LVD CIB test, should it also conduct the LVD DBS test at these same speeds? Why or why not?

—If the Agency continues to perform DBS testing in NCAP, is it appropriate to revise when the manual (robotic) brake application is initiated to a time that corresponds to 1.0 second after the FCW alert is issued (regardless of whether a CIB activation occurs after the FCW alert but before initiation of the manual brake application)? If not, why, and what prescribed TTC values would be appropriate for the modified DBS test conditions?

(41) Is the assessment method NHTSA has proposed for the CIB and DBS tests (*i.e.,* one trial per test speed with speed increments of 10 kph (6.2 mph) for each test condition and repeat trials only in the event of POV contact) appropriate? Why or why not? Should an alternative assessment method such as multiple trials be required instead? If yes, why? If multiple trials should be required, how many would be appropriate, and why? Also, what would be an acceptable pass rate, and why? If the proposed assessment method is appropriate, it is acceptable even for the LVD test scenario if only one or two test speeds are selected for inclusion? Or, is it more appropriate to alternatively require 7 trials for each test speed, and require that 5 out of the 7 trials conducted pass the ''no contact'' performance criterion?

(42) The Agency's proposal to (1) consolidate its FCW and CIB tests such that the CIB tests would also serve as an indicant of FCW operation, (2) assess 14 test speeds for CIB (5 for LVS, 5 for LVM, and potentially 4 for LVD), and (3) assess 6 tests speeds for DBS (2 for LVS, 2 for LVM, and potentially 2 for LVD), would result in a total of 20 unique combinations of test conditions and test speeds to be evaluated for AEB. If the Agency uses check marks to give credit to vehicles that (1) are equipped with the recommended ADAS technologies, and (2) pass the applicable system performance test requirements for each ADAS technology included in NCAP until such time as a new ADAS rating system is developed and a final rule to amend the safety rating section of the Monroney label is published, what is an appropriate minimum pass rate for AEB performance evaluation? For example, a vehicle is considered to meet the AEB performance if it passes two-thirds of the 20 unique combinations of test conditions and test speeds (*i.e.,* passes 14 unique combinations of test conditions and test speeds).

(43) As fused camera-radar forward-looking sensors are becoming more

prevalent in the vehicle fleet, and the Agency has not observed any instances of false positive test failures during any of its CIB or DBS testing, is it appropriate to remove the false positive STP assessments from NCAP's AEB (*i.e.,* CIB and DBS) evaluation matrix in this NCAP update? Why or why not?

(44) For vehicles with regenerative braking that have setting options, the Agency is proposing to choose the ''off'' setting, or the setting that provides the lowest deceleration when the accelerator is fully released. As mentioned, this proposal also applies to the Agency's PAEB tests. Are the proposed settings appropriate? Why or why not? Will regenerative braking introduce additional complications for the Agency's AEB and PAEB testing, and how could the Agency best address them?

(45) Should NCAP adopt any additional AEB tests or alter its current tests to address the ''changing'' rear-end crash problem? If so, what tests should be added, or how should current tests be modified?

(46) Are there any aspects of NCAP's current FCW, CIB, and/or DBS test procedure(s) that need further refinement or clarification? If so, what refinements or clarifications are necessary, and why?

3. FCW and AEB Comments Received in Response to 2015 RFC Notice

NHTSA received several comments in response to the December 2015 notice pertaining to NCAP's DBS and CIB tests. These included comments on FCW effective time-to-collision (TTC), false positive test scenarios, procedure clarifications, expanding testing, and the AEB strikeable target. These will be discussed over the next few subsections.

a. Forward Collision Warning (FCW) Effective Time-To-Collision (TTC)

In its response to NCAP's December 2015 notice, BMW suggested that the Agency adopt an ''effective TTC'' for NCAP's FCW test that differs from the ''absolute TTC'' currently stipulated in the associated test procedure. The manufacturer contended that the deceleration due to an activated AEB system effectively prolongs the reaction time for the driver such that ''an FCW warning with AEB intervention at an absolute TTC of 2.0 seconds is assumed to show an equal or greater effectiveness in comparison to an FCW warning at 2.4 seconds without AEB intervention.'' BMW suggested that if AEB functionality is intrinsic to the frontal crash prevention system, the assessment of the warning TTC in the FCW performance test should consider the time gained by AEB deceleration and therefore the Agency should assess the ''effective TTC,'' not an ''absolute TTC.''

The Agency agrees with BMW that FCW and AEB are interrelated and is thus proposing to assess the presence of an FCW alert as an integral component of the CIB test. To assess the adequacy of the FCW alert in that context, the Agency has proposed to evaluate the presence of a vehicle's FCW system during its CIB tests by requiring the SV accelerator pedal be fully released within 500 ms after the FCW alert is issued. If no FCW alert is issued during a CIB test, the SV accelerator pedal will be fully released within 500 ms after the onset of CIB system braking. If no FCW alert is issued and the vehicle's CIB system does not offer any braking, release of the SV accelerator pedal will not be required prior to impact with the POV. The Agency believes that this proposal is philosophically aligned with BMW's request, as it would no longer require the direct assessment of FCW timing relative to an ''absolute TTC.'' Rather, FCW timing, and how it relates to the intended onset of CIB activation, would be at the discretion of the vehicle manufacturer (who will have explicit knowledge of how the operation of their vehicles' CIB systems affect the ''effective TTC''). That said, the Agency continues to believe that well-designed FCW alerts can provide significant safety benefits in crash-imminent rear-end crash scenarios, and encourages vehicle manufactures to present them such that the driver may be able to respond with sufficient time to avoid a crash (*i.e.,* not to solely rely on CIB activation for crash avoidance). If a vehicle manufacturer chooses to issue an FCW alert in a way that assumes a CIB intervention will effectively extend the precrash timeline, but then the AEB system does not activate under real-world driving conditions, or activates late, drivers may not have enough time to react to avoid an impending crash.

b. False Positive Test Scenarios

Citing the potential for redundancy with the three active/supplemental braking scenarios for systems exhibiting lower deceleration rates, Mobileye suggested that the Agency impose a maximum speed reduction of 2 kph (1.24 mph) for the CIB and DBS tests, or a maximum duration of braking over the maximum allowable deceleration threshold for the false positive tests. The STP test is designed to provide an indication as to whether a vehicle's AEB system may have a false activation problem. Some vehicles use haptic braking and/or low-level braking as part of their FCW alert strategy. These brake activations are not intended to slow the vehicle significantly; rather, they attempt to get the driver's attention so that he/she will respond to the crash-imminent situation. That said, it is quite possible that FCW-based braking could reduce speed more than the 2 kph (1.24 mph) threshold suggested by Mobileye.

Recognizing the potential problem for a vehicle to fail the CIB false positive test as a consequence of how its FCW system was designed to work, NHTSA built some flexibility into the assessment criteria used to evaluate how the subject vehicle (SV) responds to the STP. In the CIB test, activations can produce peak decelerations of up to 0.5g, which was beyond any FCW-based level at the time. In the DBS test, the peak deceleration of a given test trial must not exceed 150 percent of the average peak deceleration calculated for the baseline test series performed at the same nominal SV speed. These provisions are intended to tolerate small levels of deceleration, but not the larger magnitudes indicative of an AEB intervention.

BMW objected to the inclusion of the false positive test scenario in general for both DBS and CIB systems and raised concerns that such tests ''can incentivize vehicle manufacturers to focus on one artificial situation, instead of considering the myriad of potential real-world traffic situations.'' The manufacturer suggested that if this test scenario remains for DBS, then the Agency should allow manufacturers to specify a brake pedal application rate limit beyond 279 mm/s (11 in./s) and up to 400 mm/s (16 in./s) for the false positive test scenario, to harmonize with Euro NCAP requirements. BMW further stated that limiting the rate to 279 mm/s (11 in./s) could increase a DBS system's sensitivity, and thereby increase the likelihood of additional false activation events in the real world. The manufacturer mentioned that as more frontal crash prevention systems combine both FCW and AEB functionalities, speed should reduce for all pedal application speeds.

Regarding BMW's objection to continuing with the false positive test scenario for CIB and DBS in NCAP, NHTSA notes that it has requested comment on whether eliminating the false positive tests would be appropriate at this time. As discussed previously, the Agency has not observed false positive test failures in CIB or DBS testing since these ADAS technologies were added to NCAP.

If NHTSA decides it is appropriate to keep the false positive test scenario for DBS, BMW requested that manufacturers should be permitted to specify a brake pedal application rate up to 400 mm/s (16 in./s) since this is the upper brake application rate limit established by Euro NCAP. In its November 2015 final decision notice for AEB, NHTSA addressed a similar request from the Alliance, which suggested that the Agency harmonize with Euro NCAP's brake application rate range of 200 to 400 mm/s (8 to 16 in./s).[190] At the time, the Agency stated that it would retain its proposed brake application rate of 254 ± 25.4 mm/s (10 ± 1 in./s) in the DBS system performance test. In justifying this decision, NHTSA contended that the current application rate value is well within the range of the Euro NCAP specification. Also, NHTSA reasoned that the current application rate appears to be a feasible representation of the activation of DBS systems. DBS systems are designed to stop rather than slow down, but not too fast like conventional brake assist systems, which typically address emergency panic stop situations where the brake application rate exceeds 360 mm/s (14.2 in./s). For NHTSA to focus on evaluating system performance for DBS technology (not conventional brake technology), the Agency plans to retain the current brake pedal application rate of 254 ± 25.4 mm/s (10 ± 1 in./s) for the DBS test.

c. Procedure Clarifications

In response to the November 2015 final decision notice, Mobileye asked NHTSA to clarify the process of releasing the accelerator pedal within 500 ms of the FCW alert prior to braking. The commenter questioned whether the throttle was gradually released over 500 ms, or abruptly released over 50 ms. Mobileye also asked that the Agency clarify how braking is affected if there is no FCW alert, or if the FCW alert occurs very close to the brake activation.

NHTSA notes that the throttle pedal release rate is not restricted in NCAP's CIB test procedure. The test procedure requires only that the SV throttle be fully released within 500 ms after the FCW alert is issued. As previously mentioned, as part of the Agency's proposed changes to the CIB tests, it also intends to include test procedure language stating that if no FCW alert is issued during a CIB test, the SV accelerator pedal will be released within 500 ms after the onset of CIB system braking, and that if no FCW alert is issued and the vehicle's CIB system does not offer any braking, release of the SV accelerator pedal will not be required prior to impact with the POV.

With respect to how SV braking is affected, if there is no FCW alert, or if the alert happens very close to brake activation, different steps are taken for the crash imminent braking (CIB) and dynamic brake support (DBS) tests.

In the existing DBS tests, the test procedure states that the accelerator pedal must be released within 500 ms after the FCW alert is issued, but prior to the onset of the manual SV brake application by a robotic brake controller. The Agency recognizes that this can create an issue if no FCW alert occurs because the throttle may still be depressed (since no warning was issued) while the SV brakes are applied by the robot at the prescribed TTC. The Agency has documented this possibility where the SV throttle and brake pedals are applied at the same time and provided a recommendation that up to a 250 ms overlap be allowed.[191] In other words, once the SV driver detects that the robot has applied the brakes, the driver will have 250 ms to release the accelerator fully. The test would not be valid unless this criterion is met.

Although the Agency has proposed to revise when the manual (robotic) brake application is initiated to a time that corresponds to 1.0 second after the FCW alert is issued (regardless of whether a CIB activation occurs after the FCW alert but before initiation of the manual brake application) if it continues to perform DBS testing in NCAP, it has also requested comment on appropriate TTCs for the modified DBS test conditions as an alternative to this proposal. Therefore, NHTSA is also requesting comment on the following:

(47) Would a 250 ms overlap of SV throttle and brake pedal application be acceptable in instances where no FCW alert has been issued by the prescribed TTC in a DBS test, or where the FCW alert occurs very close to the brake activation. If a 250 ms overlap is not acceptable, what overlap would be acceptable?

d. Expand Testing

Magna suggested that NHTSA expand testing to encompass low light and inclement weather situations. The Agency's proposal for PAEB systems includes testing under less-than-ideal environmental conditions (specifically at nighttime). The Agency notes that approximately half (51 percent) of fatalities caused by rear-end crashes and most MAIS 1–5 injuries (80 percent) occurred under daylight conditions. Furthermore, nearly all fatalities (92 percent) and injuries (88 percent) stemming from rear-end collisions occurred in clear weather.[192] Having said that, IIHS's review of 2009–2016 rear-end crash data suggested that AEB-equipped vehicles are over-represented for crashes occurring in certain weather conditions, such as snow and ice.[193] Therefore, NHTSA is requesting comment on the following:

(48) Should the Agency pursue research in the future to assess AEB system performance under less than ideal environmental conditions? If so, what environmental conditions would be appropriate?

e. AEB Strikeable Target

Numerous commenters recommended that NHTSA harmonize its Strikeable Surrogate Vehicle (SSV) with the test target used by other testing organizations such as IIHS and Euro NCAP. The commenters reasoned that harmonization would further advance the implementation of AEB technology by reducing the development and testing burden and thereby result in lower-cost systems. Mercedes recommended that NHTSA recognize other targets as being equivalent devices to the SSV and requested that NHTSA allow vehicle manufacturers the option to choose which target is used for testing.

Currently, NHTSA uses the SSV as the principal other vehicle (POV) in NCAP testing of DBS and CIB systems. The SSV is a target vehicle modeled after a small hatchback car and fabricated from light-weight composite materials including carbon fiber and Kevlar®.[194] Using this target imposes certain limitations, most importantly the maximum speed it can be operated at, or be struck by, the SV. Due to its material properties, the SSV can inflict damage to vehicles that impact it at higher speeds.

Another target, the Global Vehicle Target (GVT), which was referenced earlier with respect to BSI (blind spot intervention) testing, resembles a white hatchback passenger car. This three-

---

[190] 80 FR 68608 (Nov. 5, 2015).

[191] Forkenbrock, G.J., & Snyder, A.S. (2015, June), *NHTSA's 2014 automatic emergency braking test track evaluations* (Report No. DOT HS 812 166), Washington, DC: National Highway Traffic Safety Administration.

[192] Swanson, E., Foderaro, F., Yanagisawa, M., Najm, W.G., & Azeredo, P. (2019, August), *Statistics of light-vehicle pre-crash scenarios based on 2011–2015 national crash data* (Report No. DOT HS 812 745), Washington, DC: National Highway Traffic Safety Administration.

[193] Cicchino, J.B. & Zuby, D.S. (2019, August), Characteristics of rear-end crashes involving passenger vehicles with automatic emergency braking, *Traffic Injury Prevention.* 2019, VOL. 20, NO. S1, S112–S118, *https://doi.org/10.1080/15389588.2019.1576172.*

[194] 80 FR 68604 (Nov. 5, 2015).

dimensional surrogate is currently used by other consumer organizations, including Euro NCAP. It is also used by many vehicle manufacturers in their internal testing to NCAP test specifications, and by NHTSA to facilitate ADAS research using pre-crash scenarios beyond those included in the Agency's FCW, CIB, and DBS test procedures.[195]

The GVT consists of 39 vinyl-covered foam pieces (held together with hook and loop fasteners) that form the structure the outer skins are attached to. It is secured to the top of a Low-Profile Robotic Vehicle (LPRV) using hook and loop fasteners, which separate upon an SV-to-GVT collision. When the GVT is hit at low speed, it is typically pushed off the LPRV but remains assembled. At higher impact speeds, the GVT breaks apart as the SV essentially drives through it, and can then be reassembled on top of the LPRV.

The use of this surrogate vehicle would allow the Agency to perform tests at higher speeds, thus increasing safety benefits. For this reason, the Agency used the GVT in its characterization study for CIB testing at higher speeds. The SSV initially limited the test speeds the Agency could adopt for CIB and DBS testing because of concerns over potential damage to the testing equipment and test vehicle. Using the GVT significantly reduces that possibility for the test speeds proposed. Also, as future upgrades for NCAP are planned, the GVT can be used to evaluate more challenging crash scenarios, such as those required for other ADAS technologies (Intersection Safety Assist and Opposing Traffic Safety Assist). NHTSA has recently docketed draft research test procedures for these technologies.[196] [197] If, in the future, the Agency was to consider adopting other test procedures requiring a strikeable target, incorporating the GVT would allow harmonization across the program.

NHTSA has conducted vehicle testing to evaluate the FCW alert and CIB intervention onset timing observed using the GVT Revision E and compared that with the timing recorded for identical tests performed with NHTSA's SSV benchmark.[198] Three light vehicles and three rear-end crash scenarios were used for this evaluation. A secondary objective of this study was to assess the characteristics and durability of the GVT for various test track configurations, specifically its dynamic stability and in-the-field reconstruction time after being struck by a test vehicle. GVT stability was evaluated using straight line and curved path maneuvers at various speeds and lateral accelerations. Reconstruction times of the GVT after impact were examined using different impact speeds, directions of impact, and assembly crew sizes.

Overall, the results from the study suggested that the onset timing of FCW and CIB systems observed during rear-end tests performed with the GVT was similar to that recorded for the SSV.[199] The GVT was also found to be physically stable and remained affixed to the robotic platform used to facilitate its movement during the high-speed longitudinal tests as well as those performed at the limit of the platform's lateral road holding capacity. Although the time between test trials was longer than that associated with use of the SSV, GVT reassembly tests demonstrated that the GVT could be reconstructed in a reasonable time between tests after being struck. However, the physical reconstruction time is one of three considerations when determining the time between tests when the GVT is used. After being reassembled and secured to the top of the robotic platform, the platform must re-establish its communication with the other equipment needed to perform the tests, and a ''zero-offset'' check is used. This check not only ensures the GVT orientation relative to the platform remains consistent for all tests, but also confirms the distance from the SV to the GVT at the point of impact is accurately reported as zero when the two first make contact.

NHTSA proposes to use the GVT in lieu of the SSV in future NCAP testing. Similar to that noted earlier regarding the use of the articulated pedestrian mannequins, the use of the GVT provides another opportunity for NHTSA to harmonize with other consumer information safety rating programs as mandated by the Bipartisan Infrastructure Law. Comments are sought on its adoption regardless of whether modifications are made to test speeds, deceleration, test scenarios, combining test procedures, et cetera, as has been discussed.

The Agency also recognizes that there have been ongoing revisions to the GVT to address its performance in other crash modes that exercise different ADAS applications. At this time, NHTSA believes the latest Revision G is appropriate for testing in NCAP. However, for the purpose of AEB testing only, NHTSA is proposing to accept manufacturer verification data for AEB tests conducted using GVT Revision F.[200] [201] It is the Agency's understanding that Revision G incorporates changes to the front, side, and oblique aspects of Revision F.[202] NHTSA believes that modifications implemented for Revision G have not altered the physical characteristics of the rear of the target such that a vehicle's performance in the rear-end crash mode would be impacted. The Agency requests comment on:

(49) The use of the GVT in lieu of the SSV in future AEB NCAP testing,

(50) whether Revisions F and G should be considered equivalent for AEB testing, and

(51) whether NHTSA should adopt a revision of the GVT other than Revision G for use in AEB testing in NCAP.

---

[195] Currently, manufacturers use test results from their internal testing and submit them to NHTSA for NCAP's recommendation of vehicles that pass its performance testing requirements.

[196] National Highway Traffic Safety Administration (2019, September), Intersection safety assist system confirmation test: Working draft, *http://www.regulations.gov,* Docket No. NHTSA–2019–0102–0006.

[197] National Highway Traffic Safety Administration (2019, September), Opposing traffic safety assist system confirmation test: Working draft. *http://www.regulations.gov,* Docket No. NHTSA–2019–0102–0008.

[198] Snyder, A.C., Forkenbrock, G.J., Davis, I.J., O'Harra, B.C., & Schnelle, S.C. (2019, July), *A test track comparison of the global vehicle target and NHTSA's strikeable surrogate vehicle* (Report No. DOT HS 812 698), Washington, DC: National Highway Traffic Safety Administration.

[199] Comparable observations were made upon review of test data from the Agency's CIB characterization testing. Upon review of test data from the Agency's CIB characterization testing, FCW and CIB onset timings for identical vehicles were highly comparable regardless of whether the SSV or GVT Revision G targets were used.

[200] While the Agency used GVT Revision E in its comparative testing with the SSV, and it believes that no significant differences exist between Revision E and Revision F that would affect AEB test results, the Agency does not believe it is necessary to accept from vehicle manufacturers AEB test data that was derived using Revision E because Revision E is no longer in production. Therefore, the Agency believes that any OEM data that is submitted should reflect the use of GVT Revision F or Revision G.

[201] Although the Agency used GVT Revision E in its comparative testing with the SSV, the Agency does not believe that modifications made for Revision F would have changed the results of that testing. It is the Agency's understanding that several modifications were made to the rear of Revision E, which included adding additional radar material to the bottom skirt of the target to attenuate internal reflections, and reducing the slope of the rear top portion of the hatchback to increase the power of the radar return.

[202] To improve the real-world characteristics from the front and side of the target, several changes to the radar treatment were integrated into the components of the GVT body for Revision G compared to Revision F, including changes to the skin and wheel treatment. There were also some minor shape changes to the front of the GVT body to improve front radar return and to the side to improve the ability to hold its shape. *http://www.dynres.com/2020/02/25/the-new-global-vehicle-target-gvt-has-arrived/.*

With respect to Mercedes' request that NHTSA consider several targets and allow manufacturers the option to choose which target is used for testing, the Agency does not believe such an approach is feasible. The Agency currently accepts and uses, for recommendation purposes on *www.NHTSA.gov,* data submitted by vehicle manufacturers for internal CIB and DBS testing that was conducted using a target other than the SSV, such as the Allgemeiner Deutscher Automobil-Club e.V (ADAC) target, which was previously used by Euro NCAP and IIHS.[203] However, during its system performance verification testing, the Agency has observed several test failures, which may be attributed to differences in target designs.

In NHTSA's November 2015 AEB final decision notice,[204] NHTSA stated that manufacturers do not need to use the SSV to generate and submit self-reported test data in support of their AEB systems that pass NCAP's system performance requirements and are recommended to consumers on the Agency's website. However, if the vehicle does not pass NCAP's system performance criteria for AEB systems during the program's random system performance verification testing, the Agency would remove the recommendation from its website. To uphold the credibility of the program and reasonably assure that consumers are receiving vehicles that meet a specified minimum performance threshold, NHTSA believes that it is critical to accept self-reported data from manufacturers that was obtained using tests conducted in accordance with NHTSA test procedures. As such, NHTSA is proposing not to accept vehicle manufacturer test data that was derived from an alternative test target other than that which is specified in NCAP's test procedures.

IV. ADAS Rating System

NHTSA is planning to create a rating system based on assessments related to the performance of ADAS technologies, including, but not necessarily limited to, the technologies already part of the program and others proposed above. Currently, NCAP places a check mark by the relevant ADAS technology on NHTSA's website, *www.nhtsa.gov,* if two conditions are met: (1) A vehicle is equipped with the safety technology recommended by NHTSA; and (2) the system meets NCAP's performance specifications. Consumers are encouraged to look for vehicles equipped with ADAS that meet NCAP's performance tests, which are intended to establish a minimum level of performance on which consumers can rely and compare among vehicles equipped with similar technologies.

In the Agency's December 2015 notice, NHTSA discussed a series of point values for the ADAS technologies at that time. These points would have been used in a star rating system for these technologies. Vehicles with ADAS that met the criteria set forth in the Agency's test procedures would earn full points if offered as standard equipment on a particular model and half points if offered only as optional equipment for that model. In response to that proposal, commenters provided mixed support regarding the feasibility and appropriateness of developing such an ADAS rating system versus the current process of just identifying the presence of recommended technologies with check marks.[205] Proponents of a rating system were generally supportive of the broad concept of rating ADAS, but did not propose specific suggestions for how the Agency could develop such a rating system. Some commenters responded that ADAS technologies have not yet matured to the point that a rating system would be appropriate, while others believed that one could be developed. In the responses for the October 1, 2018 public meeting, support still varied, even when the discussion was more focused on how the FAST Act mandate to provide crash avoidance information on the Monroney label might be fulfilled in the context of an ADAS rating system.

A. Communicating ADAS Ratings to Consumers

As mentioned previously, NHTSA's current method of providing ADAS information to consumers conveys which systems meet NCAP's system performance requirements, but provides no overall ADAS technology rating for the vehicle. However, as more emerging ADAS technologies are available in the market, the Agency believes that a rating mechanism for these systems would be more beneficial for consumers because it could better distinguish the technologies, including different levels of system performance and the technologies' life-saving potential, rather than simply listing how many technologies a given vehicle is equipped with that meet NCAP's system performance requirements. As will be discussed in the sections that follow, ADAS ratings could be communicated to consumers using stars, medals, points, or other means, thereby allowing them to make better-informed decisions. Also, the ratings could be based on the safety benefit potential afforded by vehicles' ADAS technologies and system performance. In addition, NHTSA plans to explore several approaches on how to present such rating information in the Agency's planned consumer research. In this RFC, NHTSA is soliciting input solely on the creation of an ADAS rating system, not the visual representation or placement of that rating system at points of sale. As described in greater detail below, issues related to the visual representation and placement of the rating system at points of sale will be a topic covered in future notices and research.

1. Star Rating System

NCAP currently uses 1 to 5 stars to communicate vehicle crashworthiness ratings to consumers, with both ratings for the individual tests and an overall rating. Given the familiarity that consumers have with NHTSA's current 5-star ratings system, the Agency could also consider the use of stars for a future ADAS rating system. However, the Agency has some reservations about pursuing such an approach.

A future star-based ADAS rating system could produce lower ratings for technologies than consumers are accustomed to seeing in crashworthiness and rollover resistance tests, and may cause unnecessary consumer confusion about the additional safety the technology on their vehicle provides. For instance, although NHTSA believes ADAS could potentially add significant safety benefits in addition to the crashworthiness protection afforded on vehicles, the Agency questions whether consumers would interpret 1- and 2-star ADAS ratings as conveying added benefits beyond the crashworthiness protection offered by a vehicle. In addition, vehicles that do not have any ADAS ratings could mistakenly be interpreted to have an advantage (*i.e.,* additional safety benefits) over those that have low ADAS star ratings. Thus, vehicles that have low ADAS star ratings could inadvertently discourage consumers from considering ADAS in their purchasing decisions, when in fact, those vehicles with 1- and 2-stars may offer significant safety benefits over their unrated peers.

Given these concerns, the Agency could consider reserving star ratings to convey crashworthiness results only and distinguish ADAS ratings by using another visualization approach, such as a medals system or points-based system.

---

[203] 80 FR 68604 (Nov. 5, 2015).

[204] 80 FR 68607 (Nov. 5, 2015).

[205] *https://www.regulations.gov,* Docket No. NHTSA–2015–0119.

2. Medals Rating System

Another potential method of presenting ADAS rating information to consumers could be a three-tiered award system similar in concept to Olympic medals. Presumably, most consumers are already familiar with the designations of bronze, silver, and gold as increasingly more prestigious levels of achievement.

Using an awards system (*e.g.,* medals) rather than stars to represent NCAP's rating of ADAS technologies would not only distinguish ADAS grades from crashworthiness ratings, but also visually communicate that the two ratings are conveying different types of vehicle safety information. However, it could cause consumer confusion by having two separate rating systems that consumers would need to consider and, to the extent there is a divergence between the two systems, potentially weigh against one another for a given vehicle.

3. Points-Based Rating System

NHTSA could use points to convey ADAS rating information. Points could be used in lieu of stars or medals or in addition to these alternative rating communication concepts, and they may serve as the basis for any of the potential rating system approaches discussed in the sections that follow. One advantage of a points-based system is that it can provide improved delineation in ratings, thus benefiting consumers who may want to compare ratings between several vehicle models. However, the inherent granularity of a points-based system may cause consumer confusion if conveyed in addition to another, coarser, communication rating concept, such as stars or medals. As mentioned previously, NHTSA plans to conduct consumer research surrounding the concept of an overall NCAP rating that would combine results from crashworthiness, rollover resistance, and ADAS technology testing.

4. Incorporating Baseline Risk

Another consideration for the Agency that may add value to an ADAS rating system is the notion of conveying a vehicle's performance relative to the baseline (or average) performance observed for today's vehicle fleet. As detailed later in this notice, this concept is currently an element of NCAP's crashworthiness rating system. Star ratings generated in NCAP today are a measure of how much more (or less) occupant protection (in terms of injury risk) a given vehicle affords when compared to an ''average'' vehicle. The Agency could consider incorporating the baseline concept when developing an ADAS rating system as well. For instance, today's ''average'' vehicle may achieve 60 out of a possible 100 points (or 3 out of 5 stars) during NCAP's testing. This score (or rating) may translate to a 30 percent reduction in the risk of crashes, injuries, deaths, etc. Scores (or ratings) for future vehicles, which could also potentially be tied to a percent reduction in crashes, could be compared relative to the baseline rating of today's fleet, thus affording consumers the opportunity to compare scores (or ratings) for vehicles spanning different model years.

B. ADAS Rating System Concepts

Just as there are several ways to communicate ADAS ratings to consumers, there are also several ways to rate ADAS technologies, a few of which are discussed below. As each of these rating system concepts center around vehicle performance in NCAP tests, it was necessary to consider the primary components of these tests during concept development.

1. ADAS Test Procedure Structure and Nomenclature

As discussed extensively in this notice, each ADAS technology and associated test procedure the Agency is considering for inclusion in NCAP has the potential to address a real-world safety problem. Each test procedure is designed to replicate certain injurious and fatal real-world events (termed ''scenarios'' in this new rating concept) that can be approximated in a laboratory setting to assess the capabilities of a given ADAS. Within each scenario, the Agency defines test conditions to replicate types of real-world incidents. Within each test condition, one or more test variants (as illustrated in Figures 1 and 2 below) that assess the limitations of each ADAS technology under that test condition is also defined.[206] Finally, for each test variant, the technology would have to pass a certain number of trials to receive credit for that part of the ADAS rating. Figure 1 illustrates a generic structure for describing a given ADAS test procedure and its nomenclature in NCAP.

BILLING CODE 4910–59–P

---

[206] In certain test conditions that do not have a multitude of assessments (*e.g.,* test condition variants), the test condition and assessment would be one and the same.

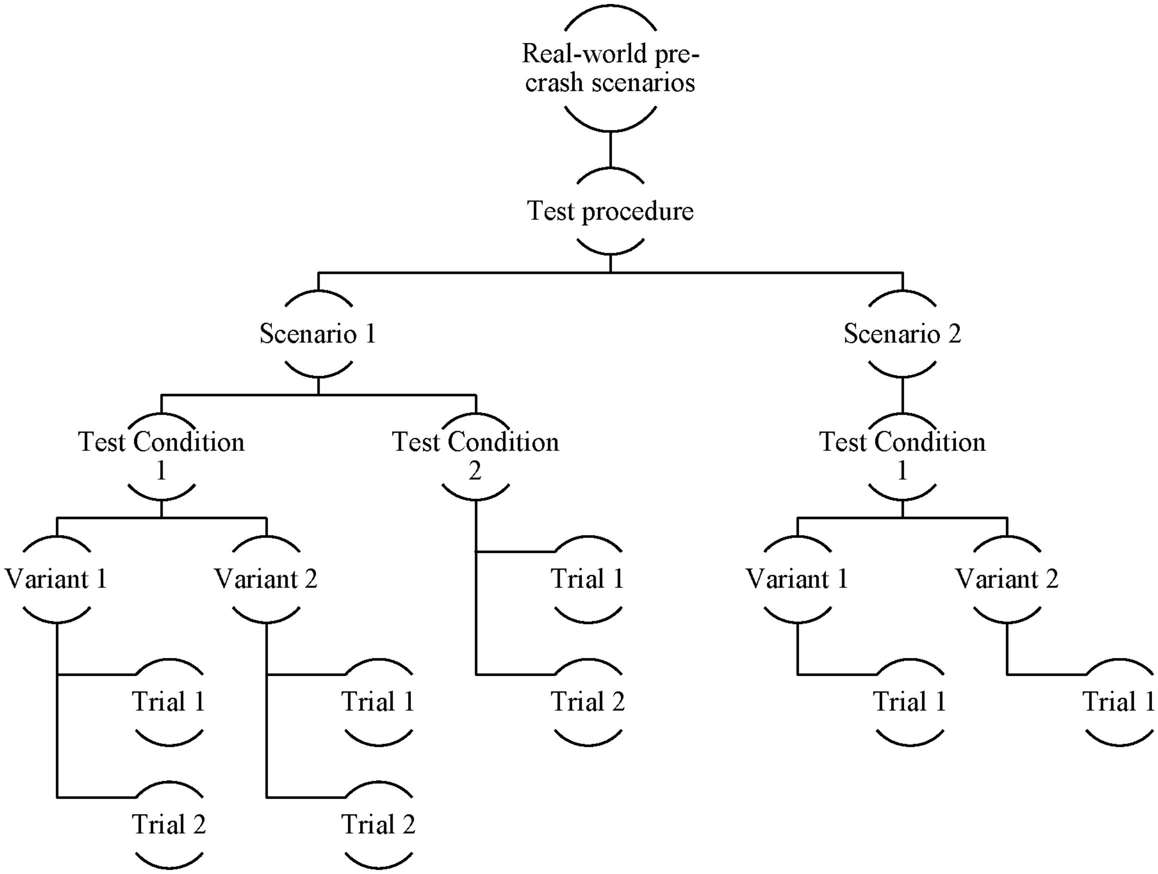

Figure 1: Generic ADAS test procedure nomenclature

The above methodology and diagram can be illustrated further using one of the ADAS technologies discussed in this document, PAEB. PAEB is intended to address a real-world safety issue involving vulnerable road users, like pedestrians. The current test procedure is designed to replicate S1 and S4 scenarios (vehicle heading straight with a pedestrian crossing the road, and a vehicle heading straight with a pedestrian walking along or against traffic, respectively). Within each scenario, one or more test conditions are defined. For example, within the S1b test scenario (as previously discussed), several test condition variants are defined. In this case, the same test condition would have to be executed at various speeds (test condition variants). Finally, NHTSA would prescribe the number of trials for which the system would have to exhibit conformance to receive credit for these particular test condition variants and, in turn, scenario. Figure 2 illustrates this example.

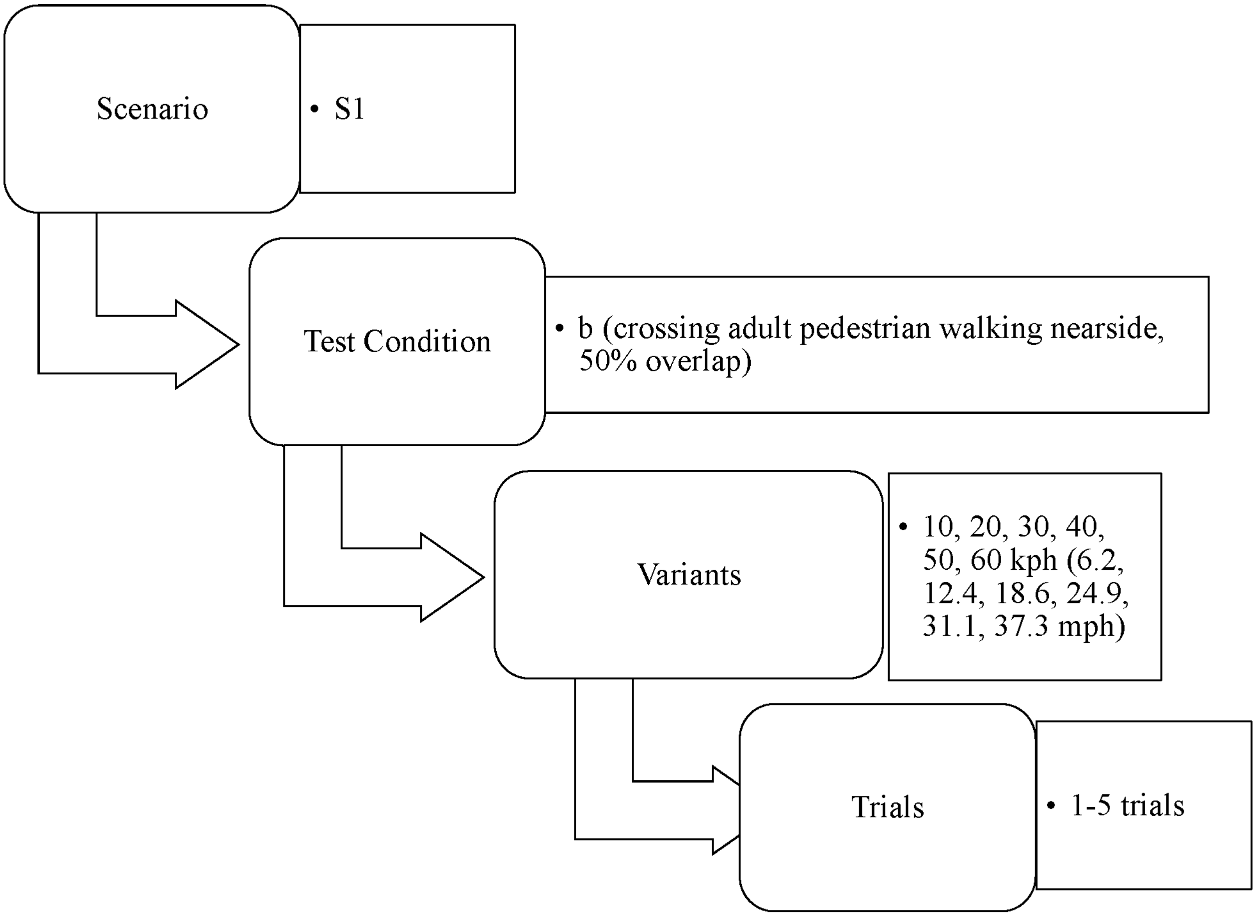

Figure 2: Scenario Sb1 of the proposed NCAP PAEB test procedure

To illustrate further the multitude of assessments simplified in Figure 1, certain test scenarios only include one test condition and one test variant. A specific example of this would be the previously mentioned Lead Vehicle Stopped (LVS) scenario, evaluated as part of the Crash Imminent Braking (CIB) test procedure, where the Subject Vehicle (SV) encounters a stopped Principal Other Vehicle (POV) on a straight road moving at 40.2 kph (25 mph). This example is illustrated in Figure 3.

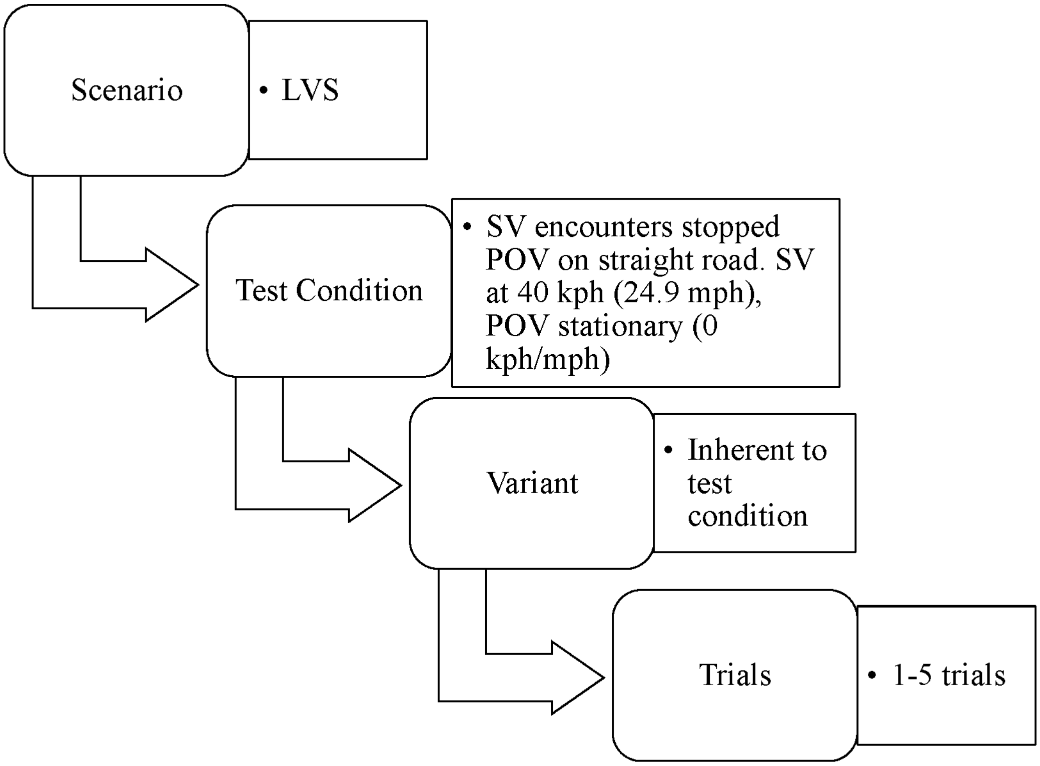

Figure 3: LVS Scenario of the NCAP CIB test procedure

BILLING CODE 4910–59–C

2. Percentage of Test Conditions To Meet—Concept 1

Given the test procedures' structure, an ADAS rating system could be designed with standards of increasing stringency that must be achieved to receive higher award levels (as shown in Table 7 below). In such a system, different ADAS technologies, each with a related test procedure (*e.g.,* FCW, CIB, LKS), are combined into categories where each technology addresses a similar crash problem. For instance, ADAS Category 1 in Table 7 could represent the Forward Collision Prevention category that would be comprised of the three forward collision prevention technologies, FCW, CIB, and DBS. Vehicles would have to meet increasing numbers of test conditions across all test procedures in that particular ADAS category (*i.e.,* three test procedures for the example given) to achieve higher ratings (*e.g.,* medals, stars, points). For the example rating system concept shown in Table 7, 50 percent of test conditions would have to be met to achieve a bronze award, 75 percent to achieve a silver award, and 100 percent to achieve a gold award for each ADAS category.[207] The lowest ADAS rating among the categories could serve as the overall ADAS award if a summary rating is established across all included ADAS technologies. Alternatively, an overall ADAS award could reflect the average ADAS rating amongst the technology categories.

TABLE 7—3-TIER ADAS RATING SYSTEM CONCEPT 1

	All test procedures & conditions in ADAS category			ADAS category award
	Bronze (50% of test conditions met)	Silver (75% of test conditions met)	Gold (100% of test conditions met)	
ADAS Category 1	Meets	Did not meet	Did not run	Bronze.
ADAS Category 2	Meets	Meets	Meets	Gold.
ADAS Category 3	Meets	Did not meet	Did not run	Bronze.
ADAS Category 4	Meets	Meets	Did not meet	Silver.
Overall ADAS Award	Bronze			

3. Select Test Conditions To Meet—Concept 2

Table 8 demonstrates another possible NCAP ADAS rating system concept. As with Concept 1, ADAS technologies are grouped into categories that address similar crash problems. Instead of having to meet a percentage of all test conditions, NCAP could specifically require certain test conditions to be met for each of three award levels. These award levels could be based on the following increasingly challenging delineations:

---

[207] When 'Did not meet' is listed for an ADAS category, the vehicle failed to pass the requirements for the test condition/variant when tested. 'Did not run' may be used to signify that the vehicle is not equipped with the technology to pass the related test procedure(s), and as such, the tests were not conducted.

(1) Bronze (Basic performers)—test conditions that are achievable for current systems to meet;

(2) Silver (Advanced performers)—test conditions that are more difficult for current systems to meet but are more easily achievable than the current known system limitations; and

(3) Gold (Highest performers)—test conditions that approach the current limits of system testing feasibility, vehicle operations, and event extremes.

Depending on a given technology's test procedure, the number of test conditions, test condition variants, and trial passes necessary to meet the Agency's requirements could vary. Thus, the ADAS performance requirements necessary for reaching each subsequent award level could be based on meeting a single test condition variant or meeting a number of test conditions. To explain further in the context of Table 8, ADAS Group 1 could be the Lane Keeping Assistance (LKA) technology category, where technology 1 could be LDW, and technology 2 could be LKS. In this example, the vehicle's LDW system meets all applicable test conditions (bronze, silver, gold). However, its LKS system fails to meet the test conditions required for silver, but meets the test conditions to earn bronze. Therefore, the highest award this vehicle could achieve for the LKA category would be bronze, as it is the highest award achieved by both of the technologies (LDW and LKS) included in the LKA category. Similar to Concept 1, the lowest or average ADAS rating amongst the category groups could serve as the overall ADAS award if a summary rating is established across all included ADAS technologies.

TABLE 8—3-TIER ADAS RATING SYSTEM CONCEPT 2

	Bronze test conditions	Silver test conditions	Gold test conditions	ADAS group award			
ADAS Group 1	1	2	3	1	2	1	Bronze.
Tech 1	Meets	Meets		Meets	Meets	Meets	
Tech 2	Meets	Meets	Meets	Meets	Did not meet	Did not run	
ADAS Group 2	1	2	3	1	2	1	Gold.
Tech 1	Meets	Meets	Meets	Meets	Meets	Meets	
Tech 2	Meets			Meets	Meets	Meets	
ADAS Group 3	1	2	3	1	2	1	Bronze.
Tech 1	Meets	Meets	Meets	Did not meet	Did not run	Did not run	
ADAS Group 4	1	2	3	1	2	1	Silver.
Tech 1	Meets	Meets	Meets	Meets	Meets	Did not meet	
Overall ADAS Award.	Bronze						

BILLING CODE 4910–59–P

A more detailed example of this ADAS rating system concept, which uses some of the test conditions and test condition variants discussed in this document (distinguished by variables such as speed), is shown below in Table 9. In this example, check marks are used to indicate that the vehicle's ADAS technology has met the requirements for a given test procedure's conditions and test condition variants. An ''X'' symbol is used to indicate where vehicles did not meet the test condition and/or variants, either because the vehicle was not equipped with the technology and therefore could not be tested, or because the vehicle's technology was tested, but failed to meet the test procedure requirements. Units are in kph unless otherwise noted.

To further explain the three-tier rating system illustrated in Table 9 with context, ADAS Group 3 in the example utilizes Blind Spot Detection (BSD) to demonstrate multiple test conditions and test condition variants. BSW (categorized as Technology 1 for the BSD grouping) has five test condition variants, and BSI (categorized as Technology 2 for the BSD grouping) includes three test condition variants. In order for BSD to achieve a bronze award in this example, the BSW system must meet the three test condition variants included for this technology under the 'Bronze Test Conditions/Variants' heading. No BSI test conditions, or test condition variants, must be met. In order for BSD to achieve a silver award, BSW must meet two test conditions (comprised of five test condition variants) and BSI must meet two test conditions, both of which are included under the 'Silver Test Conditions/ Variants' heading. If the vehicle was also able to meet the third test condition included in the BSI test procedure, 'SV Lane Change w/Closing Headway 72.4/ 80.5', which is included under the 'Gold Test Conditions/Variants' heading in Table 9, the vehicle would earn a gold award. In the Table 9 example, however, BSI does not meet one of the silver test conditions/variants ('SV Lane Change w/Constant Headway 72.4/72.4'). Consequently, in this example, BSD achieves the next lowest award—bronze.

Table 9: Example of 3-Tier ADAS Rating System Concept 2

ADAS Group	Bronze Test Conditions/Variants			Silver Test Conditions/Variants						Gold Test Conditions/Variants								ADAS Group Award
Forward Collision Prevention (ADAS Group 1)	1	2	3	1	2	3	4	5	6	1	2	3	4	5	6	7	8	**Bronze**
FCW	LVS	LVD	LVM															
	✓	✓	✓															
DBS	LVM 40.2/16.1	STP 40.2	STP 72.4	LVD	LVM 72.4/32.2					LVS								
	✓	✓	✓	✓	X					✓								
CIB	LVM 40.2/16.1	STP 40.2	STP 72.4	LVD	LVM 72.4/32.2					LVS								
	✓	✓	✓	✓	✓					X								
Lane Keeping Assistance (ADAS Group 2)	1	2	3	1	2	3	4	5	6	1	2	3	4	5	6	7	8	**Gold**
LDW	Solid White Left/Right	Dashed Yellow Left/Right	Botts' Dots Left/Right															
	✓	✓	✓															
LKS				Solid White Left/Right, 0.2 m/s	Dashed White Left/Right, 0.2 m/s	Solid White Left/Right, 0.3 m/s	Dashed White Left/Right, 0.3 m/s			Solid White Left/Right, 0.4 m/s	Dashed White Left/Right, 0.4 m/s	Solid White Left/Right, 0.5 m/s	Dashed White Left/Right, 0.5 m/s					
				✓	✓	✓	✓			✓	✓	✓	✓					
Blind Spot Detection (ADAS Group 3)	1	2	3	1	2	3	4	5	6	1	2	3	4	5	6	7	8	**Bronze**
BSW	Converge & Diverge Left/Right	Pass-by 72.4/80.5 Left/Right	Pass-by 72.4/88.5Left/Right	Pass-by 72.4/96.6 Left/Right	Pass-by 72.4/104.6 Left/Right													
	✓	✓	✓	✓	✓													
BSI				SV Lane Change w/ Constant Headway 72.4/72.4	SV Lane Change w/ Constant Headway False Positive					SV Lane Change w/ Closing Headway 72.4/80.5								
				X	✓					✓								

Forward Pedestrian Impact Avoidance (ADAS Group 4)	**1**	**2**	**3**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Silver**
PAEB	S1f, 40.2/4.8	S1g, 40.2/4.8		S1a, 16.1/4.8	S1b, 16.1/4.8	S1c, 16.1/4.8	S1d, 16.1/4.8	S4a, 16.1/0	S4b, 16.1/0	S1a, 40.2/4.8	S1b, 40.2/4.8	S1c, 40.2/4.8	S1d, 40.2/4.8	S1e, 40.2/8.0	S4a, 40.2/0	S4b, 40.2/0	S4c, 40.2/4.8	
	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	X	✓	X	
Overall ADAS Award	**Bronze**																	

BILLING CODE 4910–59–C

The approach presented in Tables 8 and 9 would address the Agency's desire to introduce a dynamic ADAS rating system. As technologies become more mature, the Agency expects ADAS system performances will begin to exceed NCAP testing requirements, and as such, systems will have an easier time meeting the required test conditions across all test procedures. The Agency could begin providing information on higher performing systems by periodically increasing the stringency of requirements to achieve the highest NCAP ratings. Lower award levels could be reserved for test conditions that are easily achieved by ADAS in the current vehicle fleet. Higher award levels could be reserved for test conditions that current ADAS have difficulty achieving, or for new test scenarios (*e.g.,* PAEB S2 or S3), conditions (*e.g.,* using a motorcycle or cyclist as the POV), or variants (*e.g.,* increased SV/POV speeds, decreased headways, additional weather conditions, varying deceleration rates) that are added to the program over time. This approach is expected to continue to provide consumers information on vehicle safety designs that introduce truly exceptional ADAS performance compared to their peers. It should also incentivize vehicle manufacturers to improve their ADAS capabilities to meet consumers' expectations for system performance.

Along these lines, NHTSA could also introduce a slight deviation to rating system Concept 2. In this deviation, not only would vehicles have to meet the most demanding requirements across all ADAS test procedures to receive higher ratings, but also the Agency could set the performance target for the highest level rating (gold, 5 stars, maximum points, etc.) for those test conditions that are required for an ADAS technology that is just emerging in the marketplace, such as Intersection Safety Assist (ISA), mentioned later in this notice. In doing so, consumers could be assured that purchasing a vehicle that earns the highest award level would offer the most advanced ADAS capabilities available at that time.

4. Weighting Test Conditions Based on Real-World Data—Concept 3

The Agency believes it is important to develop an ADAS rating system that is not only flexible (*i.e.,* one that can adapt or change over time) to keep pace with advancements in technologies, but also effective in providing consumer information that encourages the proliferation of life-saving technology. As such, a third rating system concept that the Agency could consider would be one which weights the technology groups based on the target population data and effectiveness attributable to each technology to derive the overall ADAS award. In essence, the more critical, more lifesaving, and/or more advanced/effective technology systems would have more contribution (*i.e.,* be worth more) in the rating system. Furthermore, for a given technology group, the Agency could weight the test conditions that approximate more frequent or injurious real-world events so that they have more influence in the rating for that group. The selected evaluation method could be normalized in such a way that the results of each test condition within a scenario could be appropriately combined and concisely presented for consumer information or ratings purposes. Such an approach could also be incorporated for either Concept 1 or Concept 2, discussed above.

Utilizing real-world data to inform the structure of a future ADAS rating system is challenging for several reasons. For one, there is no single metric (such as target crash populations, fatalities, or injuries) that can be used to weight every technology appropriately in a rating system when both the related real-world safety problem and meaningful influence are considered. In an effort to correlate rating system weights directly with potential real-world safety benefits, too little weight may be assigned to technologies that have lower target populations (such as those for Blind Spot Detection) compared to technologies that have much higher target populations (such as those for Forward Collision Prevention). Thus, the Agency is concerned that it may be possible for manufacturers to offer one or two ADAS systems that perform well in the NCAP tests, if those technologies with higher target populations are apportioned significant weight in a rating system, while choosing not to include the other, lower-weighted technologies on their vehicles, or opting to include them even if the systems perform poorly. Therefore, the Agency believes that it is critical to find an acceptable balance between weights dictated solely by real-world data and those that ensure each component provides a meaningful contribution to the rating system. In essence, each technology should be apportioned within the rating system such that it provides a significant contribution while also reflecting the relative safety improvement that each technology may afford consumers.

Changes in target population data (based on real-world crashes) and improvements made to ADAS technologies over time pose additional challenges for the Agency in using real-word data and system effectiveness estimates to inform appropriate weights or proportions to assign to the individual test conditions or the corresponding test condition variants in an ADAS rating system.[208] As technology systems improve to meet NCAP test scenarios/conditions, system effectiveness estimates may increase. Furthermore, as mentioned earlier in this notice, the real-world crash data may change as technologies are designed to address certain crash scenarios, but not others. Ideally, the Agency would adjust rating system weights to keep pace with these changes, as this would align with NHTSA's goal of developing a flexible ADAS rating system that can respond appropriately to improvements or changes seen for the fleet. Unfortunately, real-world data for system performance advancements is not always readily available to support dynamic program upgrades, as the crash data, which takes time to reflect changes in the vehicle fleet accurately, lags system updates and deployments.

Having said that, the Agency sees merit in using available real-world data, specifically target populations, to determine which ADAS technologies should be considered for inclusion in the program. The additional time between technology development and NHTSA's ability to collect real-world data on target populations has proven in the past to be sufficient to ensure that the technology is mature prior to considering it in NCAP. As mentioned previously, the four ADAS technologies discussed in this proposal focus on the most frequently occurring and/or most severe crash types, which the Agency believes is a feasible and prudent approach to use when considering whether an ADAS technology should be incorporated into NCAP. NHTSA will continue to leverage all information and safety studies on ADAS technologies, such as those cited in this notice, to support the Agency's proposal. In addition, NHTSA plans to leverage all available data to assess real-world insights into advanced safety technology performance.

5. Overall Rating

As discussed herein, there are many considerations when developing a potential ADAS rating system. These include: (1) What type of system to

---

[208] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

adopt; (2) whether to use points, medals, or awards to convey ratings; and (3) whether to weight system components based on real-world data. Another consideration is whether to have an overall rating. Although the concepts discussed thus far have included an overall rating, NHTSA could also simply list individual ratings for the included ADAS technologies, but not adopt an overall rating. NHTSA believes that consumers may have preferences as to which specific ADAS technologies they would or would not want on their vehicles and may be interested only in how those individual technologies perform in the Agency's testing, not in how the vehicle systems perform overall. The Agency notes that the assignment of ratings for individual technologies could simply supplement the NCAP program's existing list approach, or individual technology ratings could be listed concurrently with an overall rating. Thus, the Agency requests comment on whether an overall rating system is necessary and, if so, whether it should replace or simply supplement the existing list approach.

With regard to a future ADAS rating system, the Agency seeks comments on the following:

(52) The components and development of a full-scale ADAS rating system,

(53) the aforementioned approaches as well as others deemed appropriate for the development of a future ADAS rating system in order to assist the Agency in developing future proposals,

(54) the appropriateness of using target populations and technology effectiveness estimates to determine weights or proportions to assign to individual test conditions, corresponding test combinations, or an overall ADAS award,

(55) the use of a baseline concept to convey ADAS scores/ratings,

(56) how best to translate points/ratings earned during ADAS testing conducted under NCAP to a reduction in crashes, injuries, deaths, etc., including which real-world data metric would be most appropriate,

(57) whether an overall rating system is necessary and, if so, whether it should replace or simply supplement the existing list approach, and

(58) effective communication of ADAS ratings, including the appropriateness of using a points-based ADAS rating system in lieu of, or in addition to, a star rating system.

In responding to these approaches, or in developing new approaches for consideration, NHTSA requests that commenters consider a potential ADAS rating system that would allow flexibilities for continuous improvements to the program and cross-model year comparisons. In this notice, the Agency is seeking feedback on the appropriateness of the test scenarios, test conditions, test condition variants, and number of trials within each test variant for the four proposed technologies (PAEB, LKS, BSW, and BSI) discussed in this RFC, in addition to the four technologies currently included in NCAP. After NHTSA reviews comments in response to this notice, particularly those in response to questions raised within each of the ADAS technology sections and the rating system concepts discussed herein, the Agency anticipates finalizing the related test procedures and would then develop the selected ADAS rating system based on the technologies, test scenarios, test conditions, etc. that have support for incorporation into the program. Until NHTSA issues (1) a final decision notice announcing the new ADAS rating system and (2) a final rule to amend the safety rating section of the vehicle window sticker (Monroney label), the Agency plans to continue assigning NCAP credit, using check marks on *www.nhtsa.gov,* to vehicles that (1) are equipped with its recommended ADAS technologies, and (2) pass the applicable system performance test requirements.

V. Revising the Monroney Label (Window Sticker)

The third part to this notice relates to the Fixing America's Surface Transportation (FAST) Act, which includes a section that requires NHTSA to promulgate a rule to ensure crash avoidance information is displayed along with crashworthiness information on window stickers (also known as Monroney labels) placed on motor vehicles by their manufacturers.[209] At the time of the FAST Act, NHTSA was already in the process of developing an RFC notice to present many proposed updates to NCAP, including the evaluation of several new ADAS and a corresponding update of the Monroney label.

NHTSA currently requires vehicle manufacturers to include safety rating information, obtained from NHTSA under its NCAP program, on the Monroney labels of all new light vehicles manufactured on or after September 1, 2007 (49 CFR part 575). This requirement was mandated by Section 10307 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act; A Legacy for Users (SAFETEA–LU). The purpose of the law is to ensure that vehicle manufacturers provide consumers with relevant vehicle safety ratings information on all new light vehicles at the point of sale so that they can make informed purchasing decisions.

Although the safety rating information included on the Monroney label has provided consumers with valuable information at the point of sale, there are limitations with the current label for NCAP. For instance, currently the vehicle safety rating section of the Monroney label only includes vehicle performance information for the crashworthiness program in NCAP (known as the 5-star safety ratings), which is comprised of a full-frontal impact test, a side impact barrier test, a side impact pole test, a static measurement of the vehicle's stability factor, and a dynamic assessment of the vehicle's risk to rollover in a single-vehicle crash. The other consumer information program in NCAP, which is the ADAS technologies assessment, is not included in the current vehicle safety rating section of the Monroney label. This information is only available on *www.nhtsa.gov,* along with the 5-star safety ratings information.[210]

Thus, NHTSA plans to issue a notice of proposed rulemaking (NPRM) in 2023 to include ADAS performance information from NCAP in the vehicle safety rating section of the Monroney label, as mandated by the FAST Act. However, NHTSA seeks a flexible means to keep pace with the technological advancement and the frequent development of new ADAS technologies while also providing adequate public participation and transparency. NHTSA would like to develop a way to allow the Agency both to convey NCAP vehicle safety information in the safety rating section of the Monroney label and minimize the number of rulemaking actions needed each time the Agency incorporates a new technology in NCAP.

At this time, NHTSA believes it may be able to achieve these goals by adopting all or some combination of the following three main categories for the

---

[209] Section 24321 of the FAST Act, otherwise known as the ''Safety Through Informed Consumers Act of 2015.''

[210] 49 CFR part 575, Section 302, ''Vehicle labeling of safety rating information (compliance required for model year 2012 and later vehicles manufactured on or after January 31, 2012),'' specifies that the safety ratings information landscape should be at least 4.5 in. wide and 3.5 in. tall or cover at least 8 percent of the total area of the Monroney label—whichever is larger. Currently, any change that requires modification of the safety rating information presented on the Monroney label would require a notice and comment rulemaking action pursuant to the Administrative Procedure Act.

safety rating section of the Monroney label: (1) Crash protection information—which would be comprised of a rating (possibly one which maintains the Agency's 5-star ratings brand) that is tied to a vehicle's performance in NCAP crashworthiness and rollover testing; (2) safety technology information—which could be comprised of a rating (possibly one that uses the Agency's 5-star ratings brand, a three-tier medal award system, or points) that is tied to a vehicle's ability to avoid a crash based on its performance in ADAS testing conducted by NCAP; and (3) overall vehicle safety performance information—which could give recognition to vehicles that are top performers in both the crash protection and safety technology information categories for a given model year.

NHTSA believes that efforts to develop a label that incorporates these three main overarching categories—crash protection information, safety technology information, and overall vehicle safety performance information—should also strive to reduce the need to update the Monroney label by way of rulemaking when future changes are made to the NCAP program.

NHTSA intends to develop potential label changes by conducting consumer research. In the past, NCAP has benefitted from research on the illustration of NCAP vehicle safety information in the safety rating section of the Monroney label. NHTSA plans to conduct qualitative and quantitative consumer market research to: (1) Evaluate the overall appeal of the safety rating label concept mentioned above and identify specific likes and dislikes associated with each of the three main categories on the label; (2) measure the ease of comprehension for the safety rating label concept and understand which visual and text features are most effective at conveying vehicle safety information; (3) assess the distinctiveness of how the information is displayed and understand how best to make the vehicle safety information stand out on the Monroney label; and (4) identify additional areas of improvement related to the three potential main label categories relating to crash protection information, safety technology information, and overall vehicle performance information.[211] NHTSA plans to use the results of this research to determine how best to convey safety rating information to the public.

VI. Establishing a Roadmap for NCAP

The fourth part to this notice discusses, for the first time in NCAP, a roadmap that sets forth NHTSA's plans for upgrading NCAP over the next several years. As mentioned at the beginning of this notice, the Agency's efforts outlined herein include both NHTSA's near- and long-term strategies for upgrading NCAP.

Fulfillment of the roadmap will involve NHTSA's issuing planned proposed upgrades in phases as vehicle safety-related systems and technologies mature and data about their use and efficacy become known. The systems and technologies would include new vehicle-based crashworthiness and crash avoidance systems as well as systems-based improvements, such as occupant restraints and headlamp system performance upgrades. NHTSA would issue a final decision document following an RFC that responds to comments and provides appropriate lead time. This phased process allows stakeholders to provide data and views on proposed program updates, and allows NHTSA more flexibility to pursue program updates quicker.

Since 2015, NHTSA has worked to finalize its research on pedestrian crash protection (head, and upper and lower leg impact tests), advanced anthropomorphic test devices (crash test dummies) in frontal and side impact tests, a new frontal oblique crash test, and an updated rollover risk curve. NHTSA has included these initiatives in the mid-term component of the 10-year roadmap because the Agency reasonably believes they would meet the four prerequisites for inclusion in NCAP.[212] Initiatives in the mid-term component of the 10-year roadmap identify and prioritize safety opportunities and technologies that are practical and for which objective tests and criteria, and other consumer data exist.[213]

In addition to the items in the roadmap discussed below, NHTSA is taking an unprecedented step to consider expanding NCAP to include safety technologies that may have the potential to help drivers make safe driving choices, as discussed in the next section. This aspect of NCAP would focus on the relationship between technology and behavioral safety, and would provide comparative information on devices that can shift driver behavior that contribute to crashes (*e.g.,* speeding, and drowsy-, impaired- and distracted-driving). Initiatives on these technologies could be woven into both the first and second half (*i.e.,* long-term portion) of the 10-year roadmap, depending on whether the technologies and objective tests and criteria are sufficiently developed to meet NHTSA's four prerequisites for inclusion in NCAP. Initiatives in the long-term component of the roadmap include an identification of any safety opportunity or technology not included in the mid-term component for a variety of reasons, and those initiatives that would most benefit from stakeholder input and comments from the public. The Agency believes the plans outlined below would fulfill the requirements set forth in Section 24213 of the Bipartisan Infrastructure Law for the 10-year New Car Assessment Program roadmap once this RFC is finalized.

The Bipartisan Infrastructure Law requires that NHTSA establish a roadmap for the implementation of NCAP not later than one year after the law's enactment.[214] This roadmap must cover a term of ten years, consisting of a mid-term component and a long-term component.[215] This roadmap aligns with relevant Agency priorities, performance plans, agendas, and any other relevant NHTSA plans.[216]

Additionally, the contents of the roadmap must include a plan for any changes for NCAP, which includes descriptions of actions to be carried out and shall, as applicable, incorporate objective criteria for evaluating safety technologies and reasonable time periods for changes to NCAP that include new or updated tests.[217] NHTSA has long-established criteria for evaluating safety technologies for inclusion in NCAP, which is discussed in detail earlier in this notice and in several previous notices. NHTSA also uses the notice and comment period to ensure the time periods for changes to NCAP are reasonable, and the Agency expects this practice to continue. As part of the Agency's development of next steps for NCAP, NHTSA regularly evaluates other rating systems within the United States and abroad, including whether there are safety benefits of consistency with those other rating

---

[211] NHTSA published a notice on April 28, 2020, seeking public comment on the information collection aspect of the consumer market research.

[212] The four requisites are: (1) The technology addresses a safety need; (2) system designs exist that can mitigate the safety problem; (3) the technology provides the potential for safety benefits; and (4) a performance-based objective test procedure exists that can assess system performance.

[213] Public Law 117–58, Sec. 24213.

[214] Public Law 117–58, Sec. 24213(c)(1); 49 U.S.C. 32310(b).

[215] *Id.*

[216] Public Law 117–58, Sec. 24213(c)(1); 49 U.S.C. 32310(c)(2)(A).

[217] Public Law 117–58, Sec. 24213(c)(1); 49 U.S.C. 32310(c)(1)(A).

systems.[218] There are other benefits for being consistent, but safety is NHTSA's, and thus, NCAP's, top priority.

Next, the roadmap shall include key milestones, including the anticipated start of an action, completion of an action, and effective date of an update.[219] While NHTSA can reasonably anticipate when the start of actions may occur in the mid-term portion of the roadmap, many technologies in the long-term portion of the roadmap will require additional research, test procedure development, product development and maturity, and a number of other factors that prevent the Agency from providing more detail on the anticipated start of an action. As such, NHTSA can only provide the estimated start date of 2025–2031. Completion of action is highly dependent upon the notice and comment process, and the effective date would be highly dependent on the completion of an action. Completion dates are dependent on the number and depth of the comments received in response to an RFC, along with the technical research necessary to resolve any challenging issues in the comments. Effective dates are dependent on completion dates. As such, NHTSA cannot reasonably anticipate those timelines in advance.

The Bipartisan Infrastructure Law also requires that the mid-term portion of the roadmap identify and prioritize safety opportunities and technologies that are practical and for which objective rating tests, evaluation criteria, and other consumer data exist.[220] In the mid-term portion of the roadmap, NHTSA has included only those technologies that are practical and that otherwise meet the requirements in the law. With respect to the long-term portion of the roadmap, NHTSA must identify and prioritize safety opportunities and technologies that exist or are in development.[221] NHTSA has met both of these requirements in the following sections, prioritizing safety opportunities and technologies that are practical and for which objective rating tests, evaluation criteria, and other consumer data exist in the mid-term portion, and identifying safety opportunities and technologies that exist or are in development in the long-term portion.

Any safety opportunity or technology not included in this roadmap was omitted because NHTSA is not considering inclusion in NCAP at this time.[222] In the next five years, addition of other technologies or opportunities to the roadmap would be subject to NHTSA's four prerequisites for inclusion in NCAP, the requirements of the Bipartisan Infrastructure Law for inclusion in any part of the roadmap, and the appropriateness of the technology or opportunity for a consumer information program.

Per Sec. 24213(c), NHTSA must request comment on the roadmap and review and incorporate these comments, as appropriate.[223] This RFC requests comments from the public on the roadmap. NHTSA considers the notice and comment process to be the primary form of stakeholder engagement, though the Agency reserves the right to conduct other forms of engagement to ensure that input received represents a diversity of technical background and viewpoints.[224] With regard to a roadmap, NHTSA requests feedback on the following:

(59) Identification of safety opportunities or technologies in development that could be included in future roadmaps,

(60) opportunities to benefit from collaboration or harmonization with other rating programs, and

(61) other issues to assist with long-term planning.

2021–2022 Timeframe

- As discussed in detail in this notice, NHTSA proposes to add four new ADAS technologies (LKS, BSD, BSI, and PAEB) in NCAP.
- In addition to improving the safety and protection of motor vehicle occupants, NHTSA continues its efforts and focus to improve the safety of pedestrians and vulnerable road users. NHTSA plans to propose a crashworthiness pedestrian protection testing program in NCAP in 2022. The pedestrian protection program would incorporate three crashworthiness tests (*i.e.,* head-to-hood, upper leg-to-hood leading edge, and lower leg-to-bumper) discussed in the December 2015 RFC.[225] A crashworthiness pedestrian protection testing program would measure how well passenger cars, trucks, and sport utility vehicles protect pedestrians in the event of a crash. The program would further complement the safety achieved by pedestrian automatic emergency braking by measuring the safety performance of new vehicles to pedestrian impacts and encouraging safer vehicle designs for pedestrians.

2022–2023 Timeframe

- NHTSA plans to propose using the THOR–50M in NCAP's full frontal impact tests and the WorldSID–50M in the program's side impact barrier and side impact pole tests soon after work commences to add the dummies to 49 CFR part 572 and FMVSSs.[226] The Agency would inform the public (in request for comment notices) how these crash test dummies would be utilized in various NCAP test modes.
- In the December 2015 notice, NHTSA announced it would like to include a frontal oblique crash test in NCAP.[227] In response to that notice, commenters requested that the Agency provide the public with additional information on the target population as well as costs and benefits. They also argued that countermeasure studies have not been completed and questioned the repeatability and reproducibility of both the test procedure and the oblique moving deformable barrier. NHTSA has continued its frontal oblique research and kept the public informed of its findings.[228] A cornerstone of the procedure is the use of THOR–50M dummies in the driver and right front passenger positions. NHTSA plans to determine in 2022 whether this new crash test mode is appropriate for inclusion in an FMVSS and/or NCAP. If

---

[218] Public Law 117–58, Sec. 24213(c)(1); 49 U.S.C. 32310(c)(4).

[219] Public Law 117–58, Sec. 24213(c)(1); 49 U.S.C. 32310(c)(1)(B).

[220] Public Law 117–58, Sec. 24213(c)(1); 49 U.S.C. 32310(c)(2)(A).

[221] Public Law 117–58, Sec. 24213(c)(1); 49 U.S.C. 32310(c)(2)(B).

[222] Public Law 117–58, Sec. 24213(c)(1); 49 U.S.C. 32310(c)(3).

[223] Public Law 117–58, Sec. 24213(c)(1); 49 U.S.C. 32310(e).

[224] Public Law 117–58, Sec. 24213(c)(1); 49 U.S.C. 32310(d).

[225] 80 FR 78521 (Dec. 16, 2015), pp. 78547–78550.

[226] NHTSA included new rulemakings in the Spring 2020 Regulatory Agenda that would adopt the THOR–50M and WorldSID–50M into NHTSA's regulation for anthropomorphic test devices, 49 CFR part 572 (*https://www.reginfo.gov,* RIN 2127–AM20 and *https://www.reginfo.gov,* RIN 2127–AM22, respectively). NHTSA also included rulemakings that would adopt use of the THOR–50M and WorldSID–50M at the manufacturers' option in NHTSA compliance tests for FMVSS No. 208, ''Occupant crash protection,'' (*https://www.reginfo.gov,* RIN 2127–AM21) and FMVSS No. 214, ''Side impact protection,'' (*https://www.reginfo.gov,* RIN 2127–AM23), respectively.

[227] 80 FR 78521 (Dec. 16, 2015), pages 78530 through 78531; *https://one.nhtsa.gov/Research/Crashworthiness/Small%20Overlap%20and%20Oblique%20Testing.*

[228] See *www.regulations.gov,* Docket No. NHTSA–2020–0016 for document *Repeatability and Reproducibility of Oblique Moving Deformable Barrier Test Procedure (Saunders 2018);* Saunders, J. and Parent, D., ''Repeatability and Reproducibility of Oblique Moving Deformable Barrier Test Procedure,'' SAE Technical Paper 2018–01–1055, 2018, doi:10.4271/2018–01–1055; *https://rosap.ntl.bts.gov/view/dot/41934 Structural Countermeasure Research Program; https://www.nhtsa.gov/crash-simulation-vehicle-models Vehicle Interior and Restraint Modeling* and *Structural Countermeasure Research Program* sections.

a determination is made to include the test in NCAP, the notice and comment process would follow soon thereafter.

- NHTSA will consider incorporating several additional advanced crash avoidance technologies including lighting systems for improved nighttime pedestrian visibility into NCAP in the near future, and will be announcing next steps during this timeframe. These include: (1) Adaptive driving beam headlights; (2) upgraded lower beam headlighting; (3) semiautomatic headlamp beam-switching; and (4) rear automatic braking for pedestrian protection.

2023–2024 Timeframe

- A multi-year consumer research effort is underway to modernize the vehicle safety rating section of the Monroney label. Once the consumer research is complete, the Agency plans to begin a rulemaking action in 2023 to update the Monroney label with a new labeling concept.
- Also in 2023, NHTSA plans to commence revising its 5-star safety ratings system. The Agency has sought comment on several approaches to provide consumers with vehicle safety ratings that provide more meaningful safety information and discriminate performance of vehicles among the fleet. NHTSA discusses this issue in detail in a section below.

2025–2031 Timeframe

In NHTSA's long-term component of the roadmap, NHTSA includes a variety of technologies and foci that attempt to overcome many safety challenges for which the technologies available may not be as mature or may warrant additional study from NHTSA. NHTSA is seeking stakeholder input on the appropriateness of each of these technologies for the program and whether commenters believe that these technologies will meet the program's four prerequisites within the next 5- or 10-year time frame.

NHTSA will be further assessing and developing tests for the following crash avoidance technologies: (1) Intersection safety assist; (2) opposing traffic safety assist; and (3) automatic emergency braking for all vulnerable road users (including bicyclists and motorcyclists) in all major crash scenarios including when the vehicle is turning left or right. NHTSA will also be assessing the effectiveness of systems that are or will become available in the fleet. The Agency hopes that information will be available that would support a proposal in 2025 or beyond to include these three technologies in NCAP.

Based on comments received from stakeholders, if a technology development is mature and the available data in the next several years meet the Agency's four prerequisites, NHTSA would issue a proposal for inclusion in NCAP during the five-year mid-term timeline.

VII. Adding Emerging Vehicle Technologies for Safe Driving Choices

NCAP has traditionally focused on crashworthiness technologies that protect the vehicle occupants in the event of a collision. The more advanced ADAS technologies that are the focus of this notice take the next step and provide technologies that can assist drivers, or in certain cases correct drivers' action in ways that can avoid or mitigate crashes. NHTSA has also begun to consider ways NCAP could be used to encourage technologies that protect road users other than the vehicles occupants, such as pedestrians and pedalcyclists.

As beneficial as these technologies may be, NHTSA recognizes that risky driving behaviors and poor driver choices continue to amplify crash, injury, and fatality risks on our roadways. Accordingly, NHTSA is interested in safety technologies that have the ability to address the prevalent driver behaviors that contribute to roadway fatalities. For example, there are several available and emerging safety technologies that have the potential to address speeding and drowsy-, impaired-, distracted-, and unbelted-driving, thereby reducing the risk of crashes that lead to injury or death, which are the subjects of analysis, research, and examination.

NHTSA is exploring opportunities to encourage the development and deployment of these technologies. While more must be known about the effectiveness and consumer acceptance of these systems, NHTSA strongly believes that these technologies will mature and show efficacy. In the nearer term, then, the Agency sees potential in highlighting vehicles equipped with these technologies on its website, and possibly elsewhere, to improve public awareness, and encourage vehicle manufacturer development and adoption. NHTSA will conduct research to develop objective test procedures and criteria to evaluate the performance and effectiveness of these technologies. Initiatives on these technologies would be woven into both the first and second half (*i.e.,* long-term portion) of the 10-year roadmap, depending on whether the technologies and objective tests and criteria are sufficiently developed to meet NHTSA's four prerequisites for inclusion in NCAP.

A. Driver Monitoring Systems

Driver monitoring systems use a variety of sensors and software to detect and/or infer driver state based on estimation approaches. For example, certain types of driver monitoring systems have shown promise in detecting the state of a driver's drowsiness.[229] As vehicle technologies have evolved, driver monitoring systems have been more commonly introduced and applied to various driver states, particularly as one of the countermeasures against potential misuse of ADAS. Currently, there are varied approaches to driver monitoring across vehicle and equipment manufacturers.

NHTSA is considering adding driver monitoring systems as an NCAP technology to encourage further deployment of effective driver monitoring systems into vehicles. NHTSA seeks comment on the following to help the Agency determine whether to implement driver monitoring systems in NCAP:

(62) What are the capabilities of the various available approaches to driver monitoring systems (*e.g.,* steering wheel sensors, eye tracking cameras, etc.) to detect or infer different driver state measurement or estimations (*e.g.,* visual attention, drowsiness, medical incapacity, etc.)? What is the associated confidence or reliability in detecting or inferring such driver states and what supporting data exist?

(63) Of further interest are the types of system actions taken based on a driver monitoring system's estimate of a driver's state. What are the types and modes of associated warnings, interventions, and other mitigation strategies that are most effective for different driver states or impairments (*e.g.,* drowsy, medical, distraction)? What research data exist that substantiate effectiveness of these interventions?

(64) Are there relevant thresholds and strategies for performance (*e.g.,* alert versus some degree of intervention) that would warrant some type of NCAP credit?

(65) Since different driver states (*e.g.,* visual distraction and intoxication) can result in similar driving behaviors (*e.g.,* wide within-lane position variability), comments regarding opportunities and

---

[229] Brown, T., Lee, J., Schwarz, C., Fiorentino, D., McDonald, A., Traube, E., Nadler, E. (2013). Detection of Driver Impairment from Drowsiness. *23rd Enhanced Safety of Vehicles Conference,* Seoul, Republic of Korea. May 2013. Paper Number 13–0346.

tradeoffs in mitigation strategies when the originating cause is not conclusive are of specific interest.

(66) What types of consumer acceptance information (*e.g.,* consumer interest or feedback data) are available or are foreseen for implementation of different types of driver monitoring systems and associated mitigation strategies for driver impairment, drowsiness, or visual inattention? Are there privacy concerns? What are the related privacy protection strategies? Are there use or preference data on a selectable feature that could be optionally enabled by consumers (*e.g.,* for teen drivers by their parents)?

B. Driver Distraction

According to NHTSA's statistics, driver distraction resulted in at least 3,000 known deaths in 2019.[230] Often discussions regarding distracted driving center around cell phone use and texting, but distracted driving also includes other activities such adjusting the radio or climate controls or accessing other in-vehicle systems. In-vehicle devices and Human-Machine Interfaces (HMI) can be strategically designed to avoid or limit opportunities for driver distraction.[231] Easy access to manual controls in traditional or expected locations can minimize the amount of time a driver's eyes are off the road and hands are off the steering wheel, as well as the time needed for the driver to activate the control quickly in time-critical traffic conflict scenarios (*e.g.,* a driver reaches to activate the horn button in a crash-imminent situation, but finds that the control of horn activation is not in the expected, typical location).

NHTSA seeks comment on the following:

(67) What in-vehicle and HMI design characteristics would be most helpful to include in an NCAP rating that focuses on ease of use? What research data exist to support objectively characterizing ease of use for vehicle controls and displays?

(68) What are specific countermeasures or approaches to mitigate driver distraction, and what are the associated effectiveness metrics that may be feasible and appropriate for inclusion in the NCAP program? Methods may include driver monitoring and action strategies, HMI design considerations, expanded in-motion secondary task lockouts, phone application/notification limitations while paired with the vehicle, etc.

(69) What distraction mitigation measures could be considered for NCAP credit?

C. Alcohol Detection

Alcohol-impaired driving continues to be a pervasive contributing factor to roadway fatalities, with over 10,000 deaths in the U.S. in 2019.[232] NHTSA has explored many ways in which alcohol-impaired driving risks can be effectively mitigated both through vehicle technologies and strategic public outreach and enforcement.[233] In 2020, NHTSA published a Request for Information notice seeking input on *Impaired Driving Technologies* in the **Federal Register**.[234] Specifically, the notice requested information on available or late stage technology under development for impaired driving detection and mitigation. A total of 12 comments were received.[235] Comments were submitted about emerging technologies that can directly measure impairment though blood alcohol concentration at the beginning of a trip as well as technologies that infer alcohol impairment through a combination of driver monitoring and other vehicle sensors tracking during the course of a trip.

NHTSA seeks comment on the following aspects of alcohol detection systems:

(70) Are there opportunities for including alcohol-impairment technology in NCAP? What types of metrics, thresholds, and tests could be considered? Could voluntary deployment or adoption be positively influenced through NCAP credit?

(71) How can NCAP procedures be described in objective terms that could be inclusive of various approaches, such as detection systems and inference systems? Are there particular challenges with any approach that may need special considerations? What supporting research data exist that document relevant performance factors such as sensing accuracy and detection algorithm efficacy?

(72) When a system detects alcohol-impairment during the course of a trip, what actions could the system take in a safe manner? What are the safety considerations related to various options that manufacturers may be considering (*e.g.,* speed reduction, performing a safe stop, pulling over, or flasher activation)? How should various actions be considered for NCAP credit?

(73) What is known related to consumer acceptance of alcohol-impaired driving detection and mitigation functions, and how may that differ with respect to direct measurement approaches versus estimation techniques using a driver monitoring system? What consumer interest or feedback data exist relating to this topic? Are there privacy concerns or privacy protection strategies with various approaches? What are the related privacy protection strategies?

D. Seat Belt Interlocks

Seat belt use in passenger vehicles saved an estimated 14,955 lives in 2017.[236] The national seat belt use rate in the United States was 90.7 percent in 2019.[237] Among the 22,215 passenger vehicle occupants killed in 2019, almost half (47 percent) were unrestrained. For those passenger vehicle occupants who survived crashes where someone else died, only 14 percent were unrestrained compared to 47 percent of those who died.[238] [239]

Currently, NHTSA uses an array of countermeasures, including the Click It or Ticket campaign and State primary enforcement laws, to encourage seat belt use. The Agency requires seat belt reminders for the driver's seat.[240] As of the 2018 model year, about 95 percent of vehicles voluntarily offer front passenger warnings. NHTSA also informs consumers searching for vehicle ratings on *www.NHTSA.gov* as to the availability of optional front passenger and rear seat belt reminder systems, which typically provide a visual and auditory warning to the driver at the onset of a trip and if a passenger unbuckles during a trip.

Methods for detecting seat belt misuse have advanced in recent years. A 2018 NHTSA report, ''Performance Assessment of Prototype Seat Belt Misuse Detection System,'' showed that

---

[230] National Center for Statistics and Analysis. (2020, December). *Overview of Motor Vehicle Crashes in 2019.* (Traffic Safety Facts. Report No. DOT HS 813 060). Washington, DC: National Highway Traffic Safety Administration.

[231] In 2013, NHTSA published ''Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices.'' These voluntary guidelines apply to original equipment in-vehicle electronic devices used by the driver to perform secondary tasks (communications, entertainment, information gathering, navigation tasks, etc. are considered secondary tasks) through visual-manual means. *https://www.federalregister.gov/documents/2013/04/26/2013-09883/visual-manual-nhtsa-driver-distraction-guidelines-for-in-vehicle-electronic-devices.*

[232] Ibid.

[233] NHTSA has researched the Driver Alcohol Detection System for Safety (DADSS) program.

[234] 85 FR 71987 (November 12, 2020).

[235] *https://www.regulations.gov/document/NHTSA-2020-0102-0001/comment.*

[236] DOT HS 812 683. Latest agency estimate available.

[237] DOT HS 812 875.

[238] DOT HS 813 060.

[239] Based on known restraint use. Restraint use was unknown for 8.7 percent of passenger vehicle occupant fatalities in 2019.

[240] 49 CFR 571.208.

the system correctly identified seat belt misuse in 95 percent of trials on average across multiple common seat belt misuse scenarios.[241] This type of seat belt misuse or non-use detection could be coupled with various types of seat belt interlock systems to encourage seat belt use. Although NHTSA is not aware of any such system being currently in production, various prototype systems have been developed by manufacturers.[242] These systems could include transmission interlock, ignition interlock, and entertainment system interlock. Such systems could prevent drivers from shifting into gear, starting their vehicle, or using their vehicle's entertainment system, respectively, if the driver and/or front passenger is unbelted. Another potential strategy could be speed limiter interlock systems. Such a system could first issue a seat belt reminder warning if the driver begins driving and is unbelted, and then automatically reduce vehicle speed to a very low speed after a certain warning period if the driver remains unbelted.

NHTSA requests comment on the following related to seat belt interlock systems:

(74) Should NCAP consider credit for a seat belt reminder system with a continuous or intermittent audible signal that does not cease until the seat belt is properly buckled (*i.e.,* after the 60 second FMVSS No. 208 minimum)? What data are available to support associated effectiveness? Are certain audible signal characteristics more effective than others?

(75) Is there an opportunity for including a seat belt interlock assessment in NCAP?

(76) If the Agency were to encourage seat belt interlock adoption through NCAP, should all interlock system approaches be considered, or only certain types? If so, which ones? What metrics could be evaluated for each? Should differing credit be applied depending upon interlock system approach?

(77) Should seat belt interlocks be considered for all seating positions in the vehicle, or only the front seats? Could there be an opportunity for differentiation in this respect?

(78) What information is known or anticipated with respect to consumer acceptance of seat belt interlock systems and/or persistent seat belt reminder systems in vehicles? What consumer interest or feedback data exist on this topic?

(79) Could there be an NCAP opportunity in a selectable feature that could be optionally engaged such as in the context of a ''teen mode'' feature?

E. Intelligent Speed Assist

Speeding continues to be one of the critical factors in fatal crashes on American roadways. Specifically, driving too fast for conditions and exceeding the posted limit are two prevalent factors that contribute to traffic crashes. For more than two decades, NHTSA has identified speed as being a factor in at least nearly one-third of all motor vehicle related fatalities. For example, in 2019, of the 36,096 traffic-related fatalities occurred on U.S. roadways, 9,478 of those were positively identified as speeding-related.[243] These totals may underreport speeding, potentially to a significant degree, as they are based on whether any driver in the crash was charged with a speeding-related offense or if a police officer indicated that racing, driving too fast for conditions, or exceeding the posted speed limit was a contributing factor in the crash. As this reporting is based on aggregated police actions rather than an engineering analysis of individual crashes, it may tend to underestimate the presence of speeding, particularly in crashes where the speeding was not clearly obvious but still a factor in either the occurrence or severity of the crash.

Too few drivers view speeding as an immediate risk to their personal safety or the safety of others, including pedestrians and vulnerable road users. Yet, the consequences of speeding include: Greater potential for loss of vehicle control; reduced effectiveness of occupant protection equipment; increased stopping distance after the driver perceives a danger; increased degree of crash severity leading to more severe injuries; economic implications of a speed-related crash; and increased fuel consumption and cost. The probability of death, disfigurement, or debilitating injury grows with higher speed at impact.

NHTSA engages with State and local jurisdictions as well as national law enforcement partners to provide funding and educational materials which address speeding. Speed limiter features, which prevent a vehicle from traveling over a certain speed by limiting engine power, are available in the U.S. market and widely used in heavy-duty tractor-trailers and other fleet-based vehicles. In addition, nearly all vehicles are equipped with a mechanism that limits their top-end speed, even if that speed is quite high. These systems either prevent a vehicle from exceeding a preset specific speed regardless of location, or they use GPS and/or camera data to determine the speed limit of the current road and apply mitigation measures to reduce speeding. Vehicles equipped with an intelligent speed assist system can display the current speed limit to the driver at all times. Should the driver exceed the speed limit for the road, the system can provide a visual or auditory alert or actively slow the vehicle to an appropriate speed. Typically, many existing intelligent speed assist systems can be temporarily overridden by the driver by depressing the accelerator pedal firmly.

NHTSA is committed to addressing this important safety issue to further reduce fatalities and injuries. NHTSA requests comment on the following aspects of intelligent speed assist systems in passenger vehicles as well as other approaches that are not discussed in this notice.

(80) Should NHTSA take into consideration systems, such as intelligent speed assist systems, which determine current speed limits and warn the driver or adjust the maximum traveling speed accordingly? Should there be a differentiation between warning and intervention type intelligent speed assist systems in this consideration? Should systems that allow for some small amount of speeding over the limit before intervening be treated the same or differently than systems that are specifically keyed to a road's speed limit? What about for systems that allow driver override versus systems that do not?

(81) Are there specific protocols that should be considered when evaluating speed assist system functionality?

(82) What information is known or anticipated with respect to consumer acceptance of intelligent speed assist systems? What consumer interest or feedback data exist on this topic?

(83) Are there other means that the Agency should consider to prevent excessive speeding?

F. Rear Seat Child Reminder Assist

Data indicate that since 1998, nearly 900 children (an average of 38 per year) have died in the U.S. of hyperthermia (vehicular heatstroke) because they were left or became trapped in a hot vehicle. 2018 and 2019 saw a record number of vehicular heatstroke related deaths at 53

---

[241] DOT HS 812 496.

[242] ''NHTSA' Research on Seat Belt Interlocks,'' SAE Government Industry Meeting, January 24–26, 2018.

[243] Traffic Safety Facts 2019 ''*A Compilation of Motor Vehicle Crash Data.*'' U.S. Department of Transportation. National Highway Traffic Safety Administration.

each year.[244] Children were in the vehicles due to a variety of circumstances—some gain entry to a parked vehicle, whereas over 50 percent are forgotten in the vehicle by caregivers.[245]

To address these tragedies, many companies have developed aftermarket devices to remind parents and caregivers that a child may be left inside the vehicle. NHTSA has assessed several products and developed a test methodology for evaluating future products.[246] NHTSA subsequently opened a public docket inviting all interested parties to submit information regarding efforts or technological innovations to help prevent vehicular heatstroke.[247] Also, NHTSA has media campaigns, such as ''Where's Baby? Look Before You Lock,'' to raise awareness to parents and caregivers on the dangers of vehicular heatstroke.

In recent years, in-vehicle rear seat child reminder technology has been introduced into a number of vehicle makes and models. Many of these technological solutions utilize ''door logic'' to determine if there is potentially a child in the rear seat of the vehicle. The vehicle door logic checks to see if the rear seat doors were opened and closed at the start of the trip and then displays a reminder in the dash board with an audio cue for the driver to check the back seat when the vehicle is turned off. In September 2019, the Alliance of Automobile Manufacturers and the Association of Global Automakers (now collectively known as the Alliance for Automotive Innovation) announced that a voluntary agreement had been formed by its member companies to incorporate rear seat child reminder systems into their vehicles as standard equipment no later than the 2025 model year.[248]

NHTSA requests comment on the following issues related to rear seat child reminder systems designed to prevent vehicular heatstroke.

(84) If NHTSA considers this technology for inclusion in NCAP, are door logic solutions sufficient? Should NHTSA only consider systems that detect the presence of a child?

(85) What research data exist to substantiate differences in effectiveness of these system types?

(86) Are there specific protocols that should be considered when evaluating these in-vehicle rear seat child reminder systems?

(87) What information is known or anticipated with respect to consumer acceptance of integrated rear seat child reminder systems in vehicles? What consumer interest or feedback data exist on this topic?

VIII. Revising the 5-Star Safety Rating System

NHTSA is seeking comment on several approaches to provide consumers with vehicle safety ratings that provide more meaningful safety information and provide consumers with more ways to determine relative performance of vehicles among the fleet. In the current 5-star safety ratings system, as described in detail in the July 2008 final decision notice, injury readings recorded from crash test dummies used in NCAP's frontal impact, side impact barrier, and side impact pole tests are assessed using injury risk curves designed to predict the chance of a vehicle's occupant receiving similar injuries.[249] For each occupant in each crash test, the risks of injury to each body region assessed are combined to produce a combined probability of injury to each occupant. The combined probabilities of injury for each occupant are divided by a predetermined baseline risk of injury. This baseline risk of injury approximates the fleet average injury risk for each crash test. Dividing each combined occupant probability of injury by the baseline risk of injury results in a relative assessment of that occupant's combined injury risk versus a known fleet average. These calculations result in six summary scores for each vehicle representing the relative risk of injury for the following occupants: (1) The driver and front seat passenger in the frontal impact test; (2) the driver and rear seat passenger in the side impact barrier test; (3) the driver in the side impact pole test; and (4) the relative risk for all occupants in rollovers with respect to a baseline injury risk. These relative risks are then converted to star ratings to help consumers make informed vehicle purchasing decisions.

NHTSA seeks public comment on a few potential concepts it could use to develop a new 5-star safety ratings system in the future. Some areas of consideration discussed below could be used in conjunction with one another, while others could work better as standalone options. Ideally, any future 5-star safety ratings system should not only fulfill the program mission, but also be sufficiently flexible to allow for continuing updates to NCAP to encourage further vehicle safety improvements.

A. Points-Based Ratings System Concept

NHTSA is seeking comment on the use of a potential points-based system to calculate future 5-star safety ratings for the crashworthiness testing program when the Agency decides to update that program. In this system, star ratings could be assigned directly from point values related to the results from crash test dummies. The current system is based on a linear combination of the probability of injury for multiple body regions, some at different severity levels, which can result in some body regions being overlooked. A point-based system, on the other hand, would provide more flexibility to target injury criteria more representative of real-world injury incidence. The Agency believes that this potential method would provide more flexibility in the future when updating the program through a phased approach. For instance, new testing devices (*e.g.,* crash test dummies), procedures, injury measurements, or other criteria could be added to the 5-star-ratings system. Points could be based on critical injury risk curve values or on criteria, such as reference values from existing Federal regulations or other Agency data.

This points-based rating system approach would be similar to those used in other vehicle safety consumer information programs such as IIHS and Euro NCAP. Upper and lower performance targets would be established for each test dummy body region assessed in crash tests. Maximum points would be awarded if Injury Assessment Reference Values (IARVs) meet the lower target or better. A linearized number of points would be awarded for injury assessment values that are between the lower and upper targets. No points would be assigned for those that exceed the upper target for the respective body region (or perhaps the entire occupant). Risk curves would no longer be used exclusively to calculate a combined injury probability from the various body regions and ultimately star ratings. Critical risk curve values, IARVs, or other accepted injury limits would be used to establish performance targets and related points assignments.

---

[244] *www.noheatstroke.org.*

[245] Id.

[246] Rudd, R., Prasad, A., Weston, D., & Wietholter, K. (2015, July). Functional assessment of unattended child reminder systems. (Report No. DOT HS 812 187). Washington, DC: National Highway Traffic Safety Administration.

[247] *https://www.regulations.gov/docket?D=NHTSA-2019-0126.*

[248] *https://www.autosinnovate.org/safety/heatstroke/Automakers%20Commit%20to%20Helping%20Combat%20Child%20Heatstroke.pdf.*

[249] 73 FR 40016 (July 11, 2008), *http://regulations.gov,* Docket No. NHTSA–2006–26555–0114.

In addition to the injury criteria currently included in the 5-star safety ratings system, data to support several other injury criteria are collected for Agency monitoring and consumer information on the respective NCAP dummies (Hybrid III and ES–2re 50th percentile males, Hybrid III and SID–IIs 5th percentile females). NHTSA is seeking comment on whether any additional measurements that are not part of the existing 5-star ratings system are appropriate for use in a points-based calculation of the future star ratings.

Currently, if measurements of certain injury criteria that are included in related FMVSSs exceed standard limits, the Agency would assign a ''safety concern'' designation on its website and on the vehicle window sticker (Monroney label).[250] If measurements of certain injury criteria that are not part of FMVSSs exceed established limits, the Agency highlights those on its website (but not on the Monroney label) with footnotes. In both of these cases, the Agency seeks to inform consumers of potentially higher injury risks in body regions that are not captured by the existing 5-star safety ratings system. The Agency recognizes that consumer confusion may result from the presentation of a vehicle with high (4- or 5-star) ratings that is also assigned a safety concern or injury-related footnote. One potential solution to reduce confusion would be to implement a points-based system that allows the Agency to include the assessment of all injuries within the calculation of the star rating, even those that may not have associated risk curves. Thus, the Agency is seeking comment on the appropriate method.

Furthermore, NHTSA is exploring several options regarding the distribution of points across a potential points-based ratings system. Real-world data could be used to apportion the total number of available points to each crash mode, dummy, and/or injury value according to severity or prevalence in the field. Alternatively, each dummy or injury value could be allotted the same number of points, effectively normalizing each dummy or injury.

B. Baseline Risk Concept

Support for adjusting the baseline risk value associated with 5-star safety ratings has been mixed in the past, with some in favor and others advising against it.[251] As mentioned earlier, the Agency is again seeking comment on whether the baseline risk concept should be preserved when considering updates to its 5-star safety ratings system in the future.

With the July 2008 final decision establishing the existing 5-star safety ratings system, the concept of a relative star rating system was introduced for the first time.[252] As discussed previously, after injury readings from various body regions are converted to combined probabilities of injury risks, those combined probabilities are divided by a baseline (or average) risk of injury that is an approximation of the vehicle fleet average injury risk. Star ratings generated in NCAP today are a measure of how much more (or less) occupant protection the vehicle affords when compared to an ''average'' vehicle.

The intent of the baseline risk as described in the July 2008 notice was to update its value at regular intervals so that, as the average risk of injury decreased over time, ratings could become more stringent without changing the underlying criteria. In practice, the baseline risk has never been adjusted, which results in recent star ratings being assigned using an older benchmark less representative of current vehicle safety levels.[253]

C. Half-Star Ratings

In the December 2015 notice, the Agency sought comments on the merits of providing ratings to consumers in half-star increments. Commenters were generally supportive of the notion. In this notice, NHTSA continues to seek comment on whether the Agency should disseminate its 5-star safety ratings with half-star increments. This approach could allow better discrimination of vehicle performance for consumer information purposes by creating additional levels within the existing 1-, 2-, 3-, 4-, and 5-star levels. Though the Agency has not conducted consumer research on this potential approach, NHTSA believes that the public is familiar with the general impression of half-star ratings as it is commonly found in other consumer product rating schemes.

Future crashworthiness 5-star safety ratings systems most likely would contain more elements on which vehicles are assessed. Thus, NHTSA believes that using half-star increments may be necessary in future rating systems because they allow better discrimination of vehicle safety performance. The half-star increments, depending on future Agency decisions, could create anywhere from 9 to 11 levels[254] of discrimination for use in rating vehicles.

NHTSA could design any half-star rating system to require a vehicle to reach the minimum threshold for receiving that rating level. Ratings in a system such as this would be ''rounded down'' to the nearest half- or whole-star rating and would not be ''rounded up'' to the next half- or whole-star rating.

D. Decimal Ratings

NHTSA is also seeking comments on whether it should consider assigning star ratings using a decimal format in addition to or in place of assigning whole- or half-star ratings. The decimal rating could be based on a conversion of NCAP test results by using a linear function approach. For instance, in the current 5-star safety ratings system, this could be achieved by relating a linear function to the VSS calculation and its associated ranges. In a potential future 5-star safety ratings system, like one where the previously discussed points-based concept is used, a decimal value could also be easily integrated. Providing NCAP ratings in decimal format could provide consumers with an additional, high delineation method of discriminating vehicle performance among the fleet for purchasing reasons.

Considering these ongoing Agency initiatives currently being pursued for future NCAP upgrades, NHTSA requests comment on the following:

(88) What approaches are most effective to provide consumers with vehicle safety ratings that provide meaningful information and discriminate performance of vehicles among the fleet?

Specifically with regard to a points-based rating system, the Agency seeks comment on the following:

(89) Is the use of additional injury criteria/body regions that are not part of the existing 5-star ratings system appropriate for use in a points-based calculation of future star ratings? Some injury criteria do not have associated risk curves. Are these regions appropriate to include, and if so, what is the appropriate method by which to include them?

Regarding the baseline risk concept and the general concept of relative

---

[250] Id.

[251] This is based on comments by participants in the October 1, 2018 public meeting and respondents to the related docket *https://www.regulations.gov/docket?D=NHTSA-2018-0055.*

[252] Prior to the 2010 program enhancements, NCAP star ratings were based on an absolute, independent scale of combined injury probability. That is, the combined probability of injury from a given occupant was converted directly into a star rating with no intermediate calculation except rounding.

[253] Park, B., Rockwell, T., Collins, L., Smith, C., Aram, M. (2015), The enhanced U.S. NCAP: Five years later. *24th Enhanced Safety of Vehicles Conference,* Gothenburg, Sweden, June 2015, Paper Number 15–0314.

[254] Depending on possible rating scales from 0–5 stars, 0.5–5 stars, or 1–5 stars, the amount of total distinct ratings available would vary.

ratings, NHTSA is seeking comment on the following:

(90) Should a crashworthiness 5-star safety ratings system continue to measure a vehicle's performance based on a known or expected fleet average performer, or should it return to an absolute system of rating vehicles?

(91) Considering the basic structure of the current ratings system (combined injury risk), the potential overlapping target populations for crashworthiness and ADAS program elements, as well as other potential concepts mentioned in this document such as a points-based system, what would the best method of calculating the vehicle fleet average performance be?

(92) Should the vehicle fleet average performance be updated at regular intervals, and if so, how often?

(93) What is the most appropriate way to disseminate these updates or changes to the public?

Considering a change in approach to how to present star ratings to the public, NHTSA seeks comment on the following:

(94) Should the Agency disseminate its 5-star ratings with half-star increments?

(95) Should the Agency assign star ratings using a decimal format in addition to or in place of whole- or half-stars?

E. Rollover Resistance Testing Program

Currently, there are two rollover resistance tests that the Agency conducts and are part of the existing 5-star safety ratings system. The first component of this assessment is the static measurement of the vehicle's center of gravity height and the track width to determine the vehicle's static stability factor. The second component of this assessment is the dynamic rollover test (Fishhook test) that simulates a driver taking a panic steering action in a loss-of-control situation. The Agency uses two formulas (no tip-up and tip-up results) for calculating the risk of rollover and then assigns a rollover rating based on the risk. NHTSA sought comment on the approach published in the December 2015 notice to recalculate its current rollover risk curve given the full implementation of electronic stability control (ESC) systems as standard equipment in all vehicles manufactured on or after September 1, 2011. Commenters who responded to the December 2015 notice were generally supportive of the Agency's desire to update the rollover risk curve to reflect the role of ESC deployment. However, few specific comments on the appropriateness of the approach that was described in the notice were received at the time.

NHTSA is not proposing changes to its two existing rollover resistance tests at this time. However, when the Agency proposes changes to the existing 5-star ratings system, it may be feasible to consider an update to how it assesses the rollover resistance testing component. Thus, the Agency is seeking comment on whether any future overall vehicle ratings should continue to include rollover resistance evaluations. Also, if the Agency updates the rollover risk curve, suggestions on how to transition that data into a future overall vehicle rating would be encouraged. The Agency expects that any future overall vehicle ratings would, at minimum, require reweighting the contribution of each test mode to that overall rating and thus the need to determine the most appropriate program area to include the rollover resistance tests.

(96) Should the Agency continue to include rollover resistance evaluations in its future overall ratings?

IX. Other Activities

A. Programmatic Challenges With Self-Reported Data

Since model year 2011, vehicle manufacturers have been reporting to NHTSA their internal test data that show whether vehicles equipped with the recommended ADAS technologies pass NCAP's system performance test requirements in order to receive credit from the Agency. NHTSA assesses the information provided and then assigns check marks for systems whose conformance with NCAP's performance test requirements are supported by the data. As the Agency stated in its July 2008 final decision notice, commenters were generally supportive of NHTSA's plan to use self-reported data from the vehicle manufacturers, in conjunction with its own spot-check verification testing, to determine whether vehicles met NCAP's system performance test requirements.[255] The process by which the Agency has accepted self-reported ADAS technology data for recommended technologies has been crucial to the successful administration of the program.

However, this process has not been without challenges. Throughout the administration of the ADAS assessment program in NCAP, NHTSA has identified inconsistencies in vehicle manufacturers' self-reported data submissions. The Agency has determined that many of these inconsistencies stem from unfamiliarity with NCAP's system performance test procedures, including the use of test targets and other parameters.

It is critical to maintain program credibility and public trust when accepting manufacturers' ADAS self-reported data and disseminating it to the public. One approach to addressing some of the aforementioned challenges is to encourage all vehicle manufacturers to provide NHTSA with ADAS self-reported data from an independent test facility that meets criteria demonstrating competence in NCAP testing protocols. For instance, NHTSA's rigorous procurement process for awarding contracts to test laboratories provides that qualified laboratories meet specific competence requirements.

To address the challenges mentioned above, NHTSA is considering refusing to accept self-reported data and not posting recommendations for the vehicle's systems on its website, when:

- Manufacturers' self-reported ADAS test data is provided from a test facility that is not designated as NHTSA's contracted test laboratory, *or*
- The corresponding ADAS tests are not conducted in accordance with NCAP's testing protocols (including test devices).

NHTSA seeks comment on the following:

(97) Considering the Agency's goal of maintaining the integrity of the program, should NHTSA accept self-reported test data that is generated by test laboratories that are not NHTSA's contracted test laboratories? If no, why not? If yes, what criteria are most relevant for evaluating whether a given laboratory can acceptably conduct ADAS performance tests for NCAP such that the program's credibility is upheld?

(98) As the ADAS assessment program in NCAP continues to grow in the future to include new ADAS technologies and more complex test procedures, what other means would best address the following program challenges: Methods of data collection, maintaining data integrity and public trust, and managing test failures, particularly during verification testing?

B. Website Updates

NHTSA uses its website and the safety rating section of the Monroney label to convey to consumers vehicle safety information provided by NCAP. Although the Monroney label is an important tool NHTSA uses to communicate vehicle safety ratings to consumers at the point of sale, it has limitations:

---

[255] 72 FR 3473 (Jan. 25, 2007), Docket No. NHTSA–2006–26555.

(1) The Agency must undergo a rulemaking action to change any of its content, including minor and non-substantive changes.[256]

(2) The label is limited to a certain size, only some of which is dedicated to NCAP information, which only allows for the communication of limited safety information.

(3) By virtue of being posted on individual vehicles, the label provides limited utility as a comparative shopping tool unless compared to labels on vehicles in the same physical location.

Thus, NHTSA uses its website to communicate a wealth of information about vehicle safety beyond what is displayed on the Monroney label. NHTSA has structured the information displayed on its website to align with the structure of the Monroney label. The same crashworthiness and rollover star ratings are shown on both the label and the website. However, crash avoidance (ADAS technologies) recommendations are not included on the Monroney label because they were too new to be included at the time of the most recent Monroney label update, whereas they are provided on the website.

In light of the Monroney label limitations, increasingly complex vehicle ratings and results, and NHTSA's desire to communicate safety information as timely as possible, NHTSA is considering enhancing the information on its website. However, some of these enhancements may necessitate that the information provided on the Monroney label and website deviate from one another in structure or in content. There are limitations on the amount of information that can be usefully conveyed on the Monroney label, so NHTSA is currently considering placing some information on the website alone. However, while it makes sense to provide additional information and comparative tools on the website, NHTSA is concerned that consumers could be confused if the information in both places is not presented in the same manner. For example, the Monroney label is currently limited to displaying whole star ratings. If, as a result of this RFC, NHTSA decides to improve the differentiation between vehicles by displaying star ratings on its website using new methods like a decimal equivalent value or half-stars, such a discrepancy between the Monroney label and the website may confuse consumers.

During the October 2018 public meeting, Consumers Union suggested that NHTSA could provide ratings on its website in a ''more granular, sortable and readily comparable manner.'' Currently, the website's functionality allows for users to input limited search terms. For instance, a consumer may search for all vehicles in a given model year, all vehicles of a specific make, or vehicles with a specific model name. Consumers may then filter these results by body style, but the current body style categories are very broad and can encompass hundreds of models. Consumers are currently limited to viewing ten vehicle models at a time in search results, meaning that they may need to sift through many pages of results if they are simply browsing and do not have a particular make or model in mind. NHTSA plans to address these issues by improving the organization and versatility of the safety ratings data presented to the public.

Once a consumer selects a vehicle for further details, they may choose to compare up to three vehicles, but they must input the year, make, and model of the vehicles to be compared. NHTSA intends to make changes to its *www.nhtsa.gov* user interface to allow for simpler comparisons between vehicle manufacturers and types. For example, when a consumer searches for safety rating information for a particular make and model, similar vehicles could also be shown. These vehicles could be classified according to body style. The Agency expects to make other changes to *NHTSA.gov* to increase the comparability of safety information.

NHTSA continues to seek comment on the following aspects of vehicle information provided on its website:

(99) What is the potential for consumer confusion if information on the Monroney label and on the website differs, and how can this confusion be lessened?

(100) What types of vehicles do consumers compare during their search for a new vehicle? Do consumers often consider vehicles with different body styles (*e.g.,* midsized sedan versus large sport utility)?

(101) When searching for vehicle safety information, do consumers have a clear understanding for which vehicles they are seeking information, or do they browse through vehicle ratings to identify vehicles they may wish to purchase?

(102) When classifying vehicles by body style, what degree of classification is most appropriate? For example, when purchasing a passenger vehicle, do consumers consider all passenger vehicles, or are they inclined to narrow their searches to vehicles of a subset of passenger vehicles (*e.g.,* subcompact passenger vehicle)?

(103) Within the context of the updates considered in this notice, what is the most important top-level safety-related information that consumers should be able to compare amongst vehicles? Which of these pieces of information should consumers be able to use to sort and filter search results?

C. Database Changes

NHTSA wishes to take this opportunity to inform the public about other ways the Agency is significantly enhancing the NCAP program. We have undertaken a considerable developmental effort to modernize the OEM submission process and our processing of data, so that consumer information can be provided to consumers quickly and accurately. We are not requesting comment in this section but are presenting this information for the benefit of the reader.

Each year NHTSA requests vehicle manufacturers to submit new model year vehicle information voluntarily on new passenger cars and light trucks with gross vehicle weight ratings of 4,536 kg (10,000 pounds) or less. This information is used by NCAP primarily for consumer information on the Agency's website, presentation on the vehicle window stickers, and for the selection of new model year vehicles to be tested under NCAP.

The manner in which NHTSA and vehicle manufacturers communicate information has changed over the years—from mailed letters and faxes to spreadsheets and emails. However, NHTSA realized a modernized process of data submission, collection, analysis, and dissemination is necessary due to the ever-growing list of data elements needed to support an evolving test portfolio and diverse vehicle fleet. In the last model year alone, more than 400 makes and models of passenger vehicles were sold in the United States, thus requiring vehicle manufacturers not only to assemble detailed new vehicle data and submit them to NHTSA, but also NHTSA to collect, sort, and analyze tremendous amounts of information.

Managing this data has become more complex, utilizing electronic spreadsheets and email. In addition to processing spreadsheets from more than 20 organizations, maintaining version control, checking data for accuracy, clarifying ambiguities, sending ratings letters, and processing requests have limited the ability of the Agency's current IT systems in storing and

---

[256] The Agency implemented the Monroney label requirement by regulation (49 CFR 575.302) pursuant to Section 10307 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act; A Legacy for Users (SAFETEA–LU).

analyzing data. These limitations have been exacerbated by the incorporation of ADAS assessments into NCAP, which accepts self-reported test data from vehicle manufacturers. Historically, these ADAS technologies have been available in a mix of vehicles within a technology package or trim line at the make and model level, which can cause consumer confusion as to which vehicles have the technologies. Furthermore, as NCAP is only able to offer consumer information details at the make and model level, the additional complexity of parsing trim lines and technology packages has been overly burdensome given NHTSA's current resources and limitations.

NHTSA is mindful that any expansion in NCAP's ADAS assessment program will create a long-term need to collect considerably more data elements from vehicle manufacturers. The current data collection process of spreadsheets and emails will not suffice to fulfill this need. To that end, NHTSA has undertaken a multi-year, multi-phase project to modernize the way in which NCAP communicates with and receives data from relevant stakeholders. NHTSA is currently developing a new, secure online web portal and database that will be used to send, receive, track, store, and process program data elements and communications.

The first phase of this online portal and database development focuses on the data submission process from the vehicle manufacturers to NHTSA. The online web portal would allow designated representatives from each vehicle manufacturer to submit data and correspondence by secure and trackable means. Vehicle manufacturers would be able to have multiple representatives contribute to and approve the data submissions, and submissions could be done in a more dedicated and focused manner than is currently feasible with conventional spreadsheets. The data submission application would include business rules to help vehicle manufacturers identify invalid data or typographical errors. The database portion of the project would allow NHTSA not only to capture and store data more efficiently, but also to manage program functions more quickly—such as faster posting of NCAP ratings to the Agency's website. In addition, it would allow NCAP to determine twin and carryover status in a timelier manner. Furthermore, the database is significantly more flexible and robust than existing spreadsheets and would allow more accurate processing of manufacturers' self-reported data submitted for the ADAS assessment program as well as the side air bag out-of-position testing program. In addition, this database would allow NCAP to review vehicle fleet trends and easily compare and track changes in individual vehicle models from one model year to the next. This phase of the project has already produced a prototype, and NHTSA has received preliminary feedback from initial beta testing.

A second phase of the project will focus on data and correspondence between NHTSA and its test laboratories. NCAP collects vehicle-specific test setup information from the vehicle manufacturer and separately transmits this data to its designated test laboratory. This phase of the project would streamline the way in which the program communicates its day-to-day operations that include the review, transmission, and archive of test data. The result of these upgrades would allow NCAP to schedule tests, review test data, analyze test anomalies and failures, respond to manufacturer contests, and publish safety ratings in a timelier manner.

X. Economic Analysis

The various changes in NCAP discussed in this proposal all enable a rating system that improves consumer awareness of ADAS safety features, and encourages manufacturers to accelerate their adoption. This accelerated adoption of ADAS would drive any economic and societal impacts that result from these changes, and are thus the focus of this discussion of economic analysis. Hence, the Agency has considered the potential economic effects for ADAS technologies proposed for inclusion in NCAP and the potential benefit of introducing a rating system for ADAS technologies.

Unlike crashworthiness safety features, where safety improvements are attributable to improved occupant protection when a crash occurs, the impact that ADAS technologies have on fatality and injury rates is a direct function of their effectiveness in preventing crashes or reducing the severity of the crashes they are designed to mitigate. This effectiveness is typically measured by using real-world statistical data, laboratory testing, or Agency expertise.

With respect to vehicle safety, the Agency believes, as discussed in detail in this notice, the four proposed ADAS technologies have the potential to reduce vehicle crashes and injury severities further. As cited in this notice, researchers have conducted preliminary studies to estimate the effectiveness of ADAS technologies. Although these studies have been limited to certain models or manufacturers, which may not represent the entire fleet, they do illustrate how these systems can provide safety benefits. Thus, although the Agency does not have sufficient data to determine the monetized safety impacts resulting from these technologies in a way similar to that frequently done for mandated technologies—when compared to the future without the proposed update to NCAP, NHTSA expects that these changes would likely have substantial positive safety effects by promoting earlier and more widespread deployment of these technologies.

NCAP also helps address the issue of asymmetric information (*i.e.,* when one party in a transaction is in possession of more information than the other), which can be considered a market failure.[257] Regarding consumer information, the introduction of a potential new ADAS rating system is anticipated to provide consumers additional vehicle safety information (*e.g.,* rating based on ADAS performance and capability as well as the types of ADAS in vehicles) as opposed to the information provided in the current program (*e.g.,* check mark based on ADAS performance as pass/fail) to help them make more informed purchasing decisions by better presenting the relative safety benefits of different ADAS technologies. NHTSA believes that the future ADAS rating would increase consumer awareness and understanding of the safety benefits in these technologies, and, in turn, incentivize vehicle manufacturers to offer the ADAS technologies that lead to higher ratings across a broader selection of their vehicles. Furthermore, as these ADAS technologies mature and become more reliable and efficient, a large portion of vehicles equipped with such systems would achieve higher ADAS ratings, and in turn consumers would have an increasing number of safer vehicles to choose from. There is an unquantifiable value to consumers in receiving accurate and comparable performance information about those technologies among manufacturers, makes, and models.

According to NHTSA sponsored research,[258] IIHS/HLDI predicted that the number of vehicles equipped with ADAS technologies, including BSW and Lane Keeping Warning, will increase

---

[257] See.

[258] See *https://www.iihs.org/media/9517c308-c8d5-42e6-80fd-a69ecd9d2128/3aaYqQ/HLDI%20Research/Bulletins/hldi_bulletin_37-11.pdf.* Bulletin Vol. 34, No. 28: September 2017, ''Predicted availability and fitment of safety features on registered vehicles,'' Highway Loss Data Institute.

substantially from 2020 to 2030 and reach near full market penetration in 2050. Although the Agency has limited data on costs of ADAS technologies to consumers, assuming consumer demand for safety remains high, the future ADAS rating system would likely accelerate the full adaptation of the four technologies included in this RFC—not to mention the four existing ones. Nevertheless, the Agency does not have sufficient data, such as unit cost and information on how soon the full adaptation will be reached with the ADAS rating, to predict the net increase in cost to consumers, with a high degree of certainty.

XI. Public Participation

Interested parties are strongly encouraged to submit thorough and detailed comments relating to each of the relevant areas discussed in this notice. Please see Appendix B for a summarized list of specific questions that have been posed in this notice. Comments submitted will help the Agency make informed decisions as it strives to advance NCAP by encouraging continuous safety improvements for new vehicles and enhancing consumer information.

How do I prepare and submit comments?

To ensure that your comments are filed correctly in the docket, please include the docket number of this document in your comments.

Your comments must not be more than 15 pages long (49 CFR 553.21). NHTSA established this limit to encourage you to write your primary comments in a concise fashion. However, you may attach necessary additional documents to your comments. There is no limit on the length of the attachments.

Please submit one copy (two copies if submitting by mail or hand delivery) of your comments, including the attachments, to the docket following the instructions given above under **ADDRESSES**. Please note, if you are submitting comments electronically as a PDF (Adobe) file, NHTSA asks that the documents submitted be scanned using an Optical Character Recognition (OCR) process, thus allowing the Agency to search and copy certain portions of your submissions.

How do I submit confidential business information?

If you wish to submit any information under a claim of confidentiality, you should submit three copies of your complete submission, including the information you claim to be confidential business information, to the Office of the Chief Counsel, NHTSA, at the address given above under **FOR FURTHER INFORMATION CONTACT**. In addition, you may submit a copy (two copies if submitting by mail or hand delivery), from which you have deleted the claimed confidential business information, to the docket by one of the methods given above under **ADDRESSES**. When you send a comment containing information claimed to be confidential business information, you should include a cover letter setting forth the information specified in NHTSA's confidential business information regulation (49 CFR part 512).

Will the Agency consider late comments?

NHTSA will consider all comments received before the close of business on the comment closing date indicated above under **DATES**. To the extent possible, the Agency will also consider comments received after that date. Please note that even after the comment closing date, we will continue to file relevant information in the docket as it becomes available. Accordingly, we recommend that interested people periodically check the docket for new material. You may read the comments received at the address given above under **ADDRESSES**. The hours of the docket are indicated above in the same location. You may also see the comments on the internet, identified by the docket number at the heading of this notice, at *www.regulations.gov.*

XII. Appendices

Appendix A. Target Population Statistics for Crash Scenarios [259]

TABLE A–1—TARGET POPULATION STATISTICS, FCW/CIB/DBS

Crash scenarios [260]	Crashes	Fatalities	MAIS 1–5 injuries	PDOVs
2000 Rear-End, Lead Vehicle (LV) Stopped	1,099,868	474	561,842	1,719,177
2001 Rear-End, LV Slower	174,217	527	97,402	252,341
2002 Rear-End, LV Decelerated	374,624	155	196,731	587,031
2003 Rear-End, Other In-lane Vehicle Higher Speed	598	3	273	829
2009 Rear-End, Other/Unspecified	50,105	70	24,951	77,034
2300 Rear-End Possible, Other In-lane Vehicle Stopped	1,842	37	839	2,510
2301 Rear-End Possible, Other In-lane Vehicle Slower	813	6	486	1,063
2302 Rear-End Possible, Other In-lane Vehicle Decelerated	1,475	3	860	1,900
Combined Total	1,703,541	1,275	883,386	2,641,884
Percent of Total Crashes	29.4	3.8	31.5	36.3

TABLE A–2—TARGET POPULATION FOR LDW/LKA/LCA

Crash scenarios	Crashes	Fatalities	MAIS 1–5 injuries	PDOVs
100 1V Rollover 1st Event	4,411	63	3,155	2,104
150 2+V Rollover 1st Event	243	3	337	197
1000 1V, Roadway Departure (RD)	966,709	9,751	359,238	679,402
1050 2+V, Roadway Departure	43,957	1,021	32,069	55,856

---

[259] Wang, J.-S. (2019, March), *Target crash population for crash avoidance technologies in passenger vehicles* (Report No. DOT HS 812 653), Washington, DC: National Highway Traffic Safety Administration.

[260] The crash scenarios referenced for the FCW/CIB/DBS target population are those that comprise the subset of the 84 mutually exclusive pre-crash scenarios analyzed by VOLPE (Report No. DOT HS 812 745) that were considered relevant for the forward collision prevention crash category (Report No. DOT HS 812 653). Each of the 84 scenarios is assigned a pre-assigned number and is followed by a brief description.

TABLE A–2—TARGET POPULATION FOR LDW/LKA/LCA—Continued

Crash scenarios	Crashes	Fatalities	MAIS 1–5 injuries	PDOVs
1100 1V Cross Centerline/Median	8,560	75	2,910	6,214
1150 2+V Cross Centerline/Median	3,427	106	2,678	4,239
3000 ST Opposite Dir(OD), Head-On	32,751	2,761	37,848	23,992
3009 ST OD Forward Impact, Other	115	11	69	135
3100 ST OD, Angle Sideswipe	62,214	1,042	38,655	86,054
3200 Head-On Possible, Other Vehicle Encroaching OD	4,008	11	2,979	5,019
Combined Total	1,126,397	14,844	479,939	863,213
Percent of Total Crashes	19.4	44.3	17.1	11.9

TABLE A–3—TARGET POPULATION FOR BSD/BSI/LCM

Crash scenarios	Crashes	Fatalities	MAIS 1–5 injuries	PDOVs
8000 LCM in Rear End	48,749	128	26,040	71,977
8001 LCM in ST SD Forward Impact	212	4	62	371
8002 LCM in ST SD AS	371,504	332	129,595	651,962
8003 LCM CT VT SD	58,389	40	20,685	99,476
8004 LCM Other	24,216	38	11,924	36,940
Combined Total	503,070	542	188,304	860,726
Percent of Total Crashes	8.7	1.6	6.7	11.8

TABLE A–4—TARGET POPULATION FOR PAEB

Crash scenarios	Crashes	Fatalities	MAIS 1–5 injuries	PDOVs
300 1V2Ped RD, Forward Impact	60,322	3,264	57,480	1,836
309 1V2Ped, Other	306	26	264	0
350 2+V2Ped	511	259	452	0
400 1V2Cyc RD, Forward Impact	50,094	531	45,529	4,910
409 1V2Cyc, Other/Unspecified	175	4	172	0
450 2+V2Cyc	234	23	169	239
Combined Total	111,641	4,106	104,066	6,985
Percent of Total Crashes	1.9	12.3	3.7	0.1

TABLE A–5—TARGET POPULATION FOR RAB/RVAB/RCTA TECHNOLOGIES

Crash scenarios	Crashes	Fatalities	MAIS 1–5 injuries	PDOVs
302 1V2Ped, Backup	2,811	44	2,590	88
402 1V2Cyc, Backup	439	3	407	48
602 1V2ParkedV, Backup	41,957	2	5,293	40,389
802 1V2Fixed Object, Backup	1,824	2	217	1,732
6000 Backing Up to Vehicle/Object	101,503	23	26,761	189,059
Combined Total	148,533	74	35,268	231,317
Percent of Total Crashes	2.6	0.2	1.3	3.2

TABLE A–6—MAPPING OF CRASH SCENARIOS WITH SAFETY SYSTEMS

Crash scenarios	1 FCW/CIB/DBS	2 LDW/LKA/LCA	3 BSD/BSI/LCM	4 PAEB	5 RAB/RvAB/ RTA
100 1V Rollover 1st Event		•			
150 2+V Rollover 1st Event		•			
200 1V Jackknife 1st Event					
250 2+V Jackknife 1st Event					
300 1V2Pedestrian Roadway Departure, Forward Impact				•	
302 1V2 Pedestrian, Backup					•

TABLE A–6—MAPPING OF CRASH SCENARIOS WITH SAFETY SYSTEMS—Continued

Crash scenarios	1 FCW/CIB/DBS	2 LDW/LKA/LCA	3 BSD/BSI/LCM	4 PAEB	5 RAB/RvAB/ RTA
309 1V2 Pedestrian, Specifics Other/Unknown				•	
350 2+V2 Pedestrian				•	
400 1V2Cyclist Roadway Departure, Forward Impact				•	
402 1V2Cyclist, Backup					•
409 1V2Cyclist, Specifics Other/Unknown				•	
450 2+V2Cyclist				•	
500 1V2Animal Roadway Departure, Avoid Animal					
502 1V2Animal, Backup					
509 1V2Animal, Specifics Other/Unknown					
550 2+V2Animal					
600 1V2Parked Vehicle Roadway Departure, Forward Impact					
602 1V2Parked Vehicle, Backup					•
609 1V2Parked Vehicle, Specifics Other/Unknown					
650 2+V2Parked Vehicle					
700 1V2Other Non-Fixed Object Roadway Departure, Forward Impact					
701 1V2Other Non-Fixed Object Roadway Departure, Traction Loss					
702 1V2Other Non-Fixed Object, Backup					
709 1V2Other Non-Fixed Object, Other					
750 2+V2Other Non-Fixed Object					
800 1V2Fixed Object Roadway Departure, Forward Impact					
801 1V2Fixed Object Roadway Departure, Traction Loss					
802 1V2Fixed Object, Backup					•
809 1V2Fixed Object, Other					
850 2+V2Fixed Object					
1000 1V, Roadway Departure		•			
1001 1V RD, Traction Loss					
1002 1V RD, Avoid Vehicle/Pedestrian/Animal					
1003 1V Forward Impact, Ped or Animal					
1004 1V Forward Impact, End Departure					
1005 1V Forward Impact, Specifics Other/Unknown					
1009 1V Other/No Impact					
1050 2+V, Roadway Departure		•			
1100 1V Cross Centerline/Median		•			
1150 2+V Cross Centerline/Median *		•			
2000 Rear-End, Lead Vehicle Stopped	•				
2001 Rear-End, LV Slower	•				
2002 Rear-End, LV Decelerated	•				
2003 Rear-End, Other In-lane Vehicle Higher Speed	•				
2009 Rear-End, Specifics Other/Unknown	•				
2101 Same Trafficway Same Direction Forward Impact, Loss Control					
2102 Rear-End Possible, Same Trafficway Same Direction Forward Impact, Avoid Vehicle					
2103 Same Trafficway Same Direction Forward Impact, Avoid Objects					
2109 Rear-End Possible, Same Trafficway Same Direction Forward Impact, Specifics Other/Unknown					
2200 Same Trafficway Same Direction, Angle-Sideswipe					
2300 Rear-End Possible, Other In-lane Vehicle Stopped	•				
2301 Rear-End Possible, Other In-lane Vehicle Slower	•				
2302 Rear-End Possible, Other In-lane Vehicle Decelerated	•				
3000 Same Trafficway Opposite Direction, Head-On		•			
3001 Same Trafficway Opposite Direction Forward Impact, Traction Loss					
3002 Same Trafficway Opposite Direction Forward Impact, Avoid Vehicle					
3003 Same Trafficway Opposite Direction Forward Impact, Avoid Object					
3009 Same Trafficway Opposite Direction Forward Impact, Other		•			
3100 Same Trafficway Opposite Direction, Angle Sideswipe		•			
3200 Head-On Possible, Other Vehicle Encroaching Opposite Direction		•			

TABLE A–6—MAPPING OF CRASH SCENARIOS WITH SAFETY SYSTEMS—Continued

Crash scenarios	1 FCW/CIB/DBS	2 LDW/LKA/LCA	3 BSD/BSI/LCM	4 PAEB	5 RAB/RvAB/RTA
4000 Change Trafficway Vehicle Turning, Turn Across Path, Initial Opposite Direction					
4001 Change Trafficway Vehicle Turning, Turn Across Path, Initial Same Direction					
4009 Change Trafficway Vehicle Turning, Turn Across Path, Specifics Other/Unknown					
4100 Change Trafficway Vehicle Turning, Turn Into Path, Into Same Direction					
4101 Change Trafficway Vehicle Turning, Turn Into Path, Into Opposite Direction					
4109 Change Trafficway Vehicle Turning, Turn Into Path, Specifics Other/Unknown					
5000 Intersect Paths, Straight Across Path					
5009 Intersect Paths, Straight Path, Specifics, Specifics Other/Unknown					
6000 Backing Up to Vehicle/Object					•
7000 1V Negotiating a Curve					
7050 2+V Negotiating a Curve					
8000 Lane Change/Merge Before Rear-End			•		
8001 Lane Change/Merge in Same Trafficway Same Direction Forward Impact			•		
8002 Lane Change/Merge in Same Trafficway Same Direction Angle Sideswipe			•		
8003 Lane Change/Merge in Change Trafficway Vehicle Turning Initial Same Direction			•		
8004 Lane Change/Merge Other			•		
9000 Equipment Failure					
9020 Loss of Control Due to Tire/Engine/Poor Road					
9030 2+V, Left/Right Turn, Unspecified					
9040 2+V U-Turn					
9050 2+V Backing to Moving Vehicle					
9060 2+V No Impact					
9070 2+V Other					
9999 2+V Unknown					

Appendix B. Questions Asked Throughout This Notice

III. ADAS Performance Testing Program

(1) Should the Agency award credit to vehicles equipped with LDW systems that provide a passing alert, regardless of the alert type? Why or why not? Are there any LDW alert modalities, such as visual-only warnings, that the Agency should not consider acceptable when determining whether a vehicle meets NCAP's performance test criteria? If so, why? Should the Agency consider only certain alert modalities (such as haptic warnings) because they are more effective at re-engaging the driver and/or have higher consumer acceptance? If so, which one(s) and why?

(2) If NHTSA were to adopt the lane keeping assist test methods from the Euro NCAP LSS protocol for the Agency's LKS test procedure, should the LDW test procedure be removed from its NCAP program entirely and an LDW requirement be integrated into the LKS test procedure instead? Why or why not? For systems that have both LDW and LKS capabilities, the Agency would simply turn off LKS to conduct the LDW test if both systems are to be assessed separately. What tolerances would be appropriate for each test, and why?

(3) LKS system designs provide steering and/or braking to address lane departures (*e.g.,* when a driver is distracted). To help re-engage a driver, should the Agency specify that an LDW alert must be provided when the LKS is activated? Why or why not?

(4) Do commenters agree that the Agency should remove the Botts' Dots test scenario from the current LDW test procedure since this lane marking type is being removed from use in California? If not, why?

(5) Is the Euro NCAP maximum excursion limit of 0.3 m (1.0 ft.) over the lane marking (as defined with respect to the inside edge of the lane line) for LKS technology acceptable, or should the limit be reduced to account for crashes occurring on roads with limited shoulder width? If the tolerance should be reduced, what tolerance would be appropriate and why? Should this tolerance be adopted for LDW in addition to LKS? Why or why not?

(6) In its LSS Protocol, Euro NCAP specifies use of a 1,200 m (3,937.0 ft.) curve and a series of increasing lateral offsets to establish the desired lateral velocity of the SV towards the lane line it must respond to. Preliminary NHTSA tests have indicated that use of a 200 m (656.2 ft.) curve radius provides a clearer indication of when an LKS intervention occurs when compared to the baseline tests performed without LKS, a process specified by the Euro NCAP LSS protocol. This is because the small curve radius allows the desired SV lateral velocity to be more quickly established; requires less initial lateral offset within the travel lane; and allows for a longer period of steady state lateral velocity to be realized before an LKS intervention occurs. Is use of a 200 m (656.2 ft.) curve radius, rather than 1,200 m (3,937.0 ft.), acceptable for inclusion in a NHTSA LKS test procedure? Why or why not?

(7) Euro NCAP's LSS protocol specifies a single line lane to evaluate system performance. However, since certain LKS systems may require two lane lines before they can be enabled, should the Agency use a single line or two lines lane in its test procedure? Why?

(8) Should NHTSA consider adding Euro NCAP's road edge detection test to its NCAP program to begin addressing crashes where lane markings may not be present? If not, why? If so, should the test be added for LDW, LKS, or both technologies?

(9) The LKS and ''Road Edge'' recovery tests defined in the Euro NCAP LSS protocol specify that a range of lateral velocities from 0.2 to 0.5 m/s (0.7 to 1.6 ft./s) be used to assess system performance, and that this range is representative of the lateral velocities associated with unintended lane departures (*i.e.,* not an intended lane change). However, in the same protocol, Euro NCAP also specifies a range of lateral velocities from 0.3 to 0.6 m/s (1.0 to 2.0 ft./s) be used to represent unintended lane

departures during ''Emergency Lane Keeping—Oncoming vehicle'' and ''Emergency Lane Keeping—Overtaking vehicle'' tests. To encourage the most robust LKS system performance, should NHTSA consider a combination of the two Euro NCAP unintended departure ranges, lateral velocities from 0.2 to 0.6 m/s (0.7 to 2.0 ft./s), for inclusion in the Agency's LKS evaluation? Why or why not?

(10) As discussed above, the Agency is concerned about LKS performance on roads that are curved. As such, can the Agency correlate better LKS system performance at higher lateral velocities on straight roads with better curved road performance? Why or why not? Furthermore, can the Agency assume that a vehicle that does not exceed the maximum excursion limits at higher lateral velocities on straight roads will have superior curved road performance compared to a vehicle that only meets the excursion limits at lower lateral velocities on straight roads? Why or why not? And lastly, can the Agency assume the steering intervention while the vehicle is negotiating a curve is sustained long enough for a driver to re-engage? If not, why?

(11) The Agency would like to be assured that when a vehicle is redirected after an LKS system intervenes to prevent a lane departure when tested on one side, if it approaches the lane marker on the side not tested, the LKS will again engage to prevent a secondary lane departure by not exceeding the same maximum excursion limit established for the first side. To prevent potential secondary lane departures, should the Agency consider modifying the Euro NCAP ''lane keep assist'' evaluation criteria to be consistent with language developed for NHTSA's BSI test procedure to prevent this issue? Why or why not? NHTSA's test procedure states the SV BSI intervention shall not cause the SV to travel 0.3 m (1 ft.) or more beyond the inboard edge of the lane line separating the SV travel lane from the lane adjacent and to the right of it within the validity period. To assess whether this occurs, a second lane line is required (only one line is specified in the Euro NCAP LSS protocol for LKS testing). Does the introduction of a second lane line have the potential to confound LKS testing? Why or why not?

(12) Since most fatal road departure and opposite direction crashes occur at higher posted and known travel speeds, should the LKS test speed be increased, or does the current test speed adequately indicate performance at higher speeds, especially on straight roads? Why or why not?

(13) The Agency recognizes that the LKS test procedure currently contains many test conditions (*i.e.,* line type and departure direction). Is it necessary for the Agency to perform all test conditions to address the safety problem adequately, or could NCAP test only certain conditions to minimize test burden? For instance, should the Agency consider incorporating the test conditions for only one departure direction if the vehicle manufacturer provides test data to assure comparable system performance for the other direction? Or, should the Agency consider adopting only the most challenging test conditions? If so, which conditions are most appropriate? For instance, do the dashed line test conditions provide a greater challenge to vehicles than the solid line test conditions?

(14) What is the appropriate number of test trials to adopt for each LKS test condition, and why? Also, what is an appropriate pass rate for the LKS tests, and why?

(15) Are there any aspects of NCAP's current LDW or proposed LKS test procedure that need further refinement or clarification? Is so, what additional refinements or clarifications are necessary?

(16) Should all BSW testing be conducted without the turn signal indicator activated? Why or why not? If the Agency was to modify the BSW test procedure to stipulate activation of the turn signal indicator, should the test vehicle be required to provide an audible or haptic warning that another vehicle is in its blind zone, or is a visual warning sufficient? If a visual warning is sufficient, should it continually flash, at a minimum, to provide a distinction from the blind spot status when the turn signal is not in use? Why or why not?

(17) Is it appropriate for the Agency to use the Straight Lane Pass-by Test to quantify and ultimately differentiate a vehicle's BSW capability based on its ability to provide acceptable warnings when the POV has entered the SV's blind spot (as defined by the blind zone) for varying POV–SV speed differentials? Why or why not?

(18) Is using the GVT as the strikeable POV in the BSI test procedure appropriate? Is using Revision G in NCAP appropriate? Why or why not?

(19) The Agency recognizes that the BSW test procedure currently contains two test scenarios that have multiple test conditions (*e.g.,* test speeds and POV approach directions (left and right side of the SV)). Is it necessary for the Agency to perform all test scenarios and test conditions to address the real-world safety problem adequately, or could it test only certain scenarios or conditions to minimize test burden in NCAP? For instance, should the Agency consider incorporating only the most challenging test conditions into NCAP, such as the ones with the greatest speed differential, or choose to perform the test conditions having the lowest and highest speeds? Should the Agency consider only performing the test conditions where the POV passes by the SV on the left side if the vehicle manufacturer provides test data to assure the left side pass-by tests are also representative of system performance during right side pass-by tests? Why or why not?

(20) Given the Agency's concern about the amount of system performance testing under consideration in this RFC, it seeks input on whether to include a BSI false positive test. Is a false positive assessment needed to insure system robustness and high customer satisfaction? Why or why not?

(21) The BSW test procedure includes 7 repeated trials for each test condition (*i.e.,* test speed and POV approach direction). Is this an appropriate number of repeat trials? Why or why not? What is the appropriate number of test trials to adopt for each BSI test scenario, and why? Also, what is an appropriate pass rate for each of the two tests, BSW and BSI, and why is it appropriate?

(22) Is it reasonable to perform only BSI tests in conjunction with activation of the turn signal? Why or why not? If the turn signal is not used, how can the operation of BSI be differentiated from the heading adjustments resulting from an LKS intervention? Should the SV's LKS system be switched off during conduct of the Agency's BSI evaluations? Why or why not?

(23) Is the proposed test speed range, 10 kph (6.2 mph) to 60 kph (37.3 mph), to be assessed in 10 kph (6.2 mph) increments, most appropriate for PAEB test scenarios S1 and S4? Why or why not?

(24) The Agency has proposed to include Scenarios S1 a–e and S4 a–c in its NCAP assessment. Is it necessary for the Agency to perform all test scenarios and test conditions proposed in this RFC notice to address the safety problem adequately, or could NCAP test only certain scenarios or conditions to minimize test burden but still address an adequate proportion of the safety problem? Why or why not? If it is not necessary for the Agency to perform all test scenarios or test conditions, which scenarios/conditions should be assessed? Although they are not currently proposed for inclusion, should the Agency also adopt the false positive test conditions, S1f and S1g? Why or why not?

(25) Given that a large portion of pedestrian fatalities and injuries occur under dark lighting conditions, the Agency has proposed to perform testing for the included test conditions (*i.e.,* S1 a–e and S4 a–c) under dark lighting conditions (*i.e.,* nighttime) in addition to daylight test conditions for test speed range 10 kph (6.2 mph) to 60 kph (37.3 mph). NHTSA proposes that a vehicle's lower beams would provide the source of light during the nighttime assessments. However, if the SV is equipped with advanced lighting systems such as semiautomatic headlamp beam switching and/or adaptive driving beam head lighting system, they shall be enabled during the nighttime PAEB assessment. Is this testing approach appropriate? Why or why not? Should the Agency conduct PAEB evaluation tests with only the vehicle's lower beams and disable or not use any other advanced lighting systems?

(26) Should the Agency consider performing PAEB testing under dark conditions with a vehicle's upper beams as a light source? If yes, should this lighting condition be assessed in addition to the proposed dark test condition, which would utilize only a vehicle's lower beams along with any advanced lighting system enabled, or in lieu of the proposed dark testing condition? Should the Agency also evaluate PAEB performance in dark lighting conditions with overhead lights? Why or why not? What test scenarios, conditions, and speed(s) are appropriate for nighttime (*i.e.,* dark lighting conditions) testing in NCAP, and why?

(27) To reduce test burden in NCAP, the Agency proposed to perform one test per test speed until contact occurs, or until the vehicle's relative impact velocity exceeds 50 percent of the initial speed of the subject vehicle for the given test condition. If contact occurs and if the vehicle's relative impact velocity is less than or equal to 50 percent

of the initial SV speed for the given combination of test speed and test condition, an additional four test trials will be conducted at the given test speed and test condition, and the SV must meet the passing performance criterion (*i.e.,* no contact) for at least three out of those five test trials in order to be assessed at the next incremental test speed. Is this an appropriate approach to assess PAEB system performance in NCAP, or should a certain number of test trials be required for each assessed test speed? Why or why not? If a certain number of repeat tests is more appropriate, how many test trials should be conducted, and why?

(28) Is a performance criterion of ''no contact'' appropriate for the proposed PAEB test conditions? Why or why not? Alternatively, should the Agency require minimum speed reductions or specify a maximum allowable SV-to-mannequin impact speed for any or all of the proposed test conditions (*i.e.,* test scenario and test speed combination)? If yes, why, and for which test conditions? For those test conditions, what speed reductions would be appropriate? Alternatively, what maximum allowable impact speed would be appropriate?

(29) If the SV contacts the pedestrian mannequin during the initial trial for a given test condition and test speed combination, NHTSA proposes to conduct additional test trials only if the relative impact velocity observed during that trial is less than or equal to 50 percent of the initial speed of the SV. For a test speed of 60 kph (37.3 mph), this maximum relative impact velocity is nominally 30 kph (18.6 mph), and for a test speed of 10 kph (6.2 mph), the maximum relative impact velocity is nominally 5 kph (3.1 mph). Is this an appropriate limit on the maximum relative impact velocity for the proposed range of test speeds? If not, why? Note that the tests in Global Technical Regulation (GTR) No. 9 for pedestrian crashworthiness protection simulates a pedestrian impact at 40 kph (24.9 mph).

(30) For each lighting condition, the Agency is proposing 6 test speeds (*i.e.,* those performed from 10 to 60 kph (6.2 to 37.3 mph) in increments of 10 kph (6.2 mph)) for each of the 8 proposed test conditions (S1a, b, c, d, and e and S4a, b, and c). This results in a total of 48 unique combinations of test conditions and test speeds to be evaluated per lighting condition, or 96 total combinations for both light conditions. The Agency mentions later in the ADAS Ratings System section, that it plans to use check marks, as is done currently, to give credit to vehicles that (1) are equipped with the recommended ADAS technologies, and (2) pass the applicable system performance test requirements for each ADAS technology included in NCAP until it issues (1) a final decision notice announcing the new ADAS rating system and (2) a final rule to amend the safety rating section of the vehicle window sticker (Monroney label). For the purposes of providing credit for a technology using check marks, what is an appropriate minimum overall pass rate for PAEB performance evaluation? For example, should a vehicle be said to meet the PAEB performance requirements if it passes two-thirds of the 96 unique combinations of test conditions and test speeds for the two lighting conditions (*i.e.,* passes 64 unique combinations of test conditions and test speeds)?

(31) Given previous support from commenters to include S2 and S3 scenarios in the program at some point in the future and the results of AAA's testing for one of the turning conditions, NHTSA seeks comment on an appropriate timeframe for including S2 and S3 scenarios into the Agency's NCAP. Also, NHTSA requests from vehicle manufacturers information on any currently available models designed to address, and ideally achieve crash avoidance during conduct of the S2 and S3 scenarios to support Agency evaluation for a future program upgrade.

(32) Should the Agency adopt the articulated mannequins into the PAEB test procedure as proposed? Why or why not?

(33) In addition to tests performed under daylight conditions, the Agency is proposing to evaluate the performance of PAEB systems during nighttime conditions where a large percentage of real-world pedestrian fatalities occur. Are there other technologies and information available to the public that the Agency can evaluate under nighttime conditions?

(34) Are there other safety areas that NHTSA should consider as part of this or a future upgrade for pedestrian protection?

(35) Are there any aspects of NCAP's proposed PAEB test procedure that need further refinement or clarification before adoption? If so, what additional refinement or clarification is necessary, and why?

(36) Considering not only the increasing number of cyclists killed on U.S. roads but also the limitations of current AEB systems in detecting cyclists, the Agency seeks comment on the appropriate timeframe for adding a cyclist component to NCAP and requests from vehicle manufacturers information on any currently available models that have the capability to validate the cyclist target and test procedures used by Euro NCAP to support evaluation for a future NCAP program upgrade.

(37) In addition to the test procedures used by Euro NCAP, are there others that NHTSA should consider to address the cyclist crash population in the U.S. and effectiveness of systems?

(38) For the Agency's FCW tests:

—If the Agency retains one or more separate tests for FCW, should it award credit solely to vehicles equipped with FCW systems that provide a passing audible alert? Or, should it also consider awarding credit to vehicles equipped with FCW systems that provide passing haptic alerts? Are there certain haptic alert types that should be excluded from consideration (if the Agency was to award credit to vehicles with haptic alerts that pass NCAP tests) because they may be a nuisance to drivers such that they are more likely to disable the system? Do commenters believe that haptic alerts can be accurately and objectively assessed? Why or why not? Is it appropriate for the Agency to refrain from awarding credit to FCW systems that provide only a passing visual alert? Why or why not? If the Agency assesses the sufficiency of the FCW alert in the context of CIB (and PAEB) tests, what type of FCW alert(s) would be acceptable for use in defining the timing of the release of the SV accelerator pedal, and why?

—Is it most appropriate to test the middle (or next latest) FCW system setting in lieu of the default setting when performing FCW and AEB (including PAEB) NCAP tests on vehicles that offer multiple FCW timing adjustment settings? Why or why not? If not, what use setting would be most appropriate?

—Should the Agency consider consolidating FCW and CIB testing such that NCAP's CIB test scenarios would serve as an indicant of FCW operation? Why or why not? The Agency has proposed that if it combines the two tests, it would evaluate the presence of a vehicle's FCW system during its CIB tests by requiring the SV accelerator pedal be fully released within 500 ms after the FCW alert is issued. If no FCW alert is issued during a CIB test, the SV accelerator pedal will be fully released within 500 ms after the onset of CIB system braking (as defined by the instant SV deceleration reaches at least 0.5g). If no FCW alert is issued and the vehicle's CIB system does not offer any braking, release of the SV accelerator pedal will not be required prior to impact with the POV. The Agency notes that it has also proposed these test procedural changes for its PAEB tests as well. Is this assessment method for FCW operation reasonable? Why or why not?

—If the Agency continues to assess FCW systems separately from CIB, how should the current FCW performance criteria (*i.e.,* TTCs) be amended if the Agency aligns the corresponding maximum SV test speeds, POV speeds, SV-to-POV headway, POV deceleration magnitude, etc., as applicable, with the proposed CIB tests, and why? What assessment method should be used—one trial per scenario, or multiple trials, and why? If multiple trials should be required, how many would be appropriate, and why? Also, what would be an acceptable pass rate, and why?

—Is it desirable for NCAP to perform one FCW test scenario (instead of the three that are currently included in NCAP's FCW test procedure), conducted at the corresponding maximum SV test speed, POV speed, SV-to-POV headway (as applicable), POV deceleration magnitude, etc. of the proposed CIB test to serve as an indicant of FCW system performance? If so, which test scenario from NCAP's FCW test procedure is appropriate?

—Are there additional or alternative test scenarios or test conditions that the Agency should consider incorporating into the FCW test procedure, such as those at even higher test speeds than those proposed for the CIB tests, or those having increased complexity? If so, should the current FCW performance criteria (*i.e.,* TTCs) and/or test scenario specifications be amended, and to what extent?

(39) For the Agency's CIB tests:

—Are the SV and POV speeds, SV-to-POV headway, deceleration magnitude, etc. the Agency has proposed for NCAP's CIB tests appropriate? Why or why not? If not, what speeds, headway(s), deceleration magnitude(s) are appropriate, and why? Should the Agency adopt a POV deceleration magnitude of 0.6 g for its LVD CIB test in lieu of 0.5 g proposed? Why or why not?

—Should the Agency consider adopting additional higher tests speeds (*i.e.,* 60, 70, and/or 80 kph (37.3, 43.5, and/or 49.7 mph)) for the CIB (and potentially DBS) LVD test scenario in NCAP? Why or why not? If additional speeds are included, what headway and deceleration magnitude would be appropriate for each additional test speed, and why?

—Is a performance criterion of ''no contact'' appropriate for the proposed CIB and DBS test conditions? Why or why not? Alternatively, should the Agency require minimum speed reductions or specify a maximum allowable SV-to-POV impact speed for any or all of the proposed test conditions (*i.e.,* test scenario and test speed combination)? If yes, why, and for which test conditions? For those test conditions, what speed reductions would be appropriate? Alternatively, what maximum allowable impact speed would be appropriate?

(40) For the Agency's DBS tests:

—Should the Agency remove the DBS test scenarios from NCAP? Why or why not? Alternatively, should the Agency conduct the DBS LVS and LVM tests at only the highest test speeds proposed for CIB—70 and 80 kph (43.5 and 49.7 mph)? Why or why not? If the Agency also adopted these higher tests speeds (70 and 80 kph (43.5 and 49.7 mph)) for the LVD CIB test, should it also conduct the LVD DBS test at these same speeds? Why or why not?

—If the Agency continues to perform DBS testing in NCAP, is it appropriate to revise when the manual (robotic) brake application is initiated to a time that corresponds to 1.0 second after the FCW alert is issued (regardless of whether a CIB activation occurs after the FCW alert but before initiation of the manual brake application)? If not, why, and what prescribed TTC values would be appropriate for the modified DBS test conditions?

(41) Is the assessment method NHTSA has proposed for the CIB and DBS tests (*i.e.,* one trial per test speed with speed increments of 10 kph (6.2 mph) for each test condition and repeat trials only in the event of POV contact) appropriate? Why or why not? Should an alternative assessment method such as multiple trials be required instead? If yes, why? If multiple trials should be required, how many would be appropriate, and why? Also, what would be an acceptable pass rate, and why? If the proposed assessment method is appropriate, it is acceptable even for the LVD test scenario if only one or two test speeds are selected for inclusion? Or, is it more appropriate to alternatively require 7 trials for each test speed, and require that 5 out of the 7 trials conducted pass the ''no contact'' performance criterion?

(42) The Agency's proposal to (1) consolidate its FCW and CIB tests such that the CIB tests would also serve as an indicant of FCW operation, (2) assess 14 test speeds for CIB (5 for LVS, 5 for LVM, and potentially 4 for LVD), and (3) assess 6 tests speeds for DBS (2 for LVS, 2 for LVM, and potentially 2 for LVD), would result in a total of 20 unique combinations of test conditions and test speeds to be evaluated for AEB. What is an appropriate minimum pass rate for AEB performance evaluation? For example, a vehicle is considered to meet the AEB performance if it passes two-thirds of the 20 unique combinations of test conditions and test speeds (*i.e.,* passes 14 unique combinations of test conditions and test speeds).

(43) As fused camera-radar forward-looking sensors are becoming more prevalent in the vehicle fleet, and the Agency has not observed any instances of false positive test failures during any of its CIB or DBS testing, is it appropriate to remove the false positive STP assessments from NCAP's AEB (*i.e.,* CIB and DBS) evaluation matrix in this NCAP update? Why or why not?

(44) For vehicles with regenerative braking that have setting options, the Agency is proposing to choose the ''off'' setting, or the setting that provides the lowest deceleration when the accelerator is fully released. As mentioned, this proposal also applies to the Agency's PAEB tests. Are the proposed settings appropriate? Why or why not? Will regenerative braking introduce additional complications for the Agency's AEB and PAEB testing, and how could the Agency best address them?

(45) Should NCAP adopt any additional AEB tests or alter its current tests to address the ''changing'' rear-end crash problem? If so, what tests should be added, or how should current tests be modified?

(46) Are there any aspects of NCAP's current FCW, CIB, and/or DBS test procedure(s) that need further refinement or clarification? If so, what refinements or clarifications are necessary, and why?

(47) Would a 250 ms overlap of SV throttle and brake pedal application be acceptable in instances where no FCW alert has been issued by the prescribed TTC in a DBS test, or where the FCW alert occurs very close to the brake activation. If a 250 ms overlap is not acceptable, what overlap would be acceptable?

(48) Should the Agency pursue research in the future to assess AEB system performance under less than ideal environmental conditions? If so, what environmental conditions would be appropriate?

(49) The Agency requests comment on the use of the GVT in lieu of the SSV in future AEB NCAP testing,

(50) The Agency requests comment on whether Revisions F and G should be considered equivalent for AEB testing.

(51) The Agency requests comment on whether NHTSA should adopt a revision of the GVT other than Revision G for use in AEB testing in NCAP.

IV. ADAS Rating System

With regard to a future ADAS rating system, the Agency seeks comments on the following:

(52) The components and development of a full-scale ADAS rating system,

(53) the aforementioned approaches as well as others deemed appropriate for the development of a future ADAS rating system in order to assist the Agency in developing future proposals,

(54) the appropriateness of using target populations and technology effectiveness estimates to determine weights or proportions to assign to individual test conditions, corresponding test combinations, or an overall ADAS award,

(55) the use of a baseline concept to convey ADAS scores/ratings,

(56) how best to translate points/ratings earned during ADAS testing conducted under NCAP to a reduction in crashes, injuries, deaths, etc., including which real-world data metric would be most appropriate,

(57) whether an overall rating system is necessary and, if so, whether it should replace or simply supplement the existing list approach, and

(58) effective communication of ADAS ratings, including the appropriateness of using a points-based ADAS rating system in lieu of, or in addition to, a star rating system.

VI. Establishing a Roadmap for NCAP

With regard to a roadmap, NHTSA requests feedback on the following:

(59) Identification of safety opportunities or technologies in development that could be included in future roadmaps,

(60) opportunities to benefit from collaboration or harmonization with other rating programs, and

(61) other issues to assist with long-term planning.

VII. Adding Emerging Vehicle Technologies for Safe Driving Choices

(62) What are the capabilities of the various available approaches to driver monitoring systems (*e.g.,* steering wheel sensors, eye tracking cameras, etc.) to detect or infer different driver state measurement or estimations (*e.g.,* visual attention, drowsiness, medical incapacity, etc.)? What is the associated confidence or reliability in detecting or inferring such driver states and what supporting data exist?

(63) Of further interest are the types of system actions taken based on a driver monitoring system's estimate of a driver's state. What are the types and modes of associated warnings, interventions, and other mitigation strategies that are most effective for different driver states or impairments (*e.g.,* drowsy, medical, distraction)? What research data exist that substantiate effectiveness of these interventions?

(64) Are there relevant thresholds and strategies for performance (*e.g.,* alert versus some degree of intervention) that would warrant some type of NCAP credit?

(65) Since different driver states (*e.g.,* visual distraction and intoxication) can result in similar driving behaviors (*e.g.,* wide within-lane position variability), comments regarding opportunities and tradeoffs in mitigation strategies when the originating cause is not conclusive are of specific interest.

(66) What types of consumer acceptance information (*e.g.,* consumer interest or

feedback data) are available or are foreseen for implementation of different types of driver monitoring systems and associated mitigation strategies for driver impairment, drowsiness, or visual inattention? Are there privacy concerns? What are the related privacy protection strategies? Are there use or preference data on a selectable feature that could be optionally enabled by consumers (*e.g.,* for teen drivers by their parents)?

(67) What in-vehicle and HMI design characteristics would be most helpful to include in an NCAP rating that focuses on ease of use? What research data exist to support objectively characterizing ease of use for vehicle controls and displays?

(68) What are specific countermeasures or approaches to mitigate driver distraction, and what are the associated effectiveness metrics that may be feasible and appropriate for inclusion in the NCAP program? Methods may include driver monitoring and action strategies, HMI design considerations, expanded in-motion secondary task lockouts, phone application/notification limitations while paired with the vehicle, etc.

(69) What distraction mitigation measures could be considered for NCAP credit?

(70) Are there opportunities for including alcohol-impairment technology in NCAP? What types of metrics, thresholds, and tests could be considered? Could voluntary deployment or adoption be positively influenced through NCAP credit?

(71) How can NCAP procedures be described in objective terms that could be inclusive of various approaches, such as detection systems and inference systems? Are there particular challenges with any approach that may need special considerations? What supporting research data exist that document relevant performance factors such as sensing accuracy and detection algorithm efficacy?

(72) When a system detects alcohol-impairment during the course of a trip, what actions could the system take in a safe manner? What are the safety considerations related to various options that manufacturers may be considering (*e.g.,* speed reduction, performing a safe stop, pulling over, or flasher activation)? How should various actions be considered for NCAP credit?

(73) What is known related to consumer acceptance of alcohol-impaired driving detection and mitigation functions, and how may that differ with respect to direct measurement approaches versus estimation techniques using a driver monitoring system? What consumer interest or feedback data exist relating to this topic? Are there privacy concerns or privacy protection strategies with various approaches? What are the related privacy protection strategies?

(74) Should NCAP consider credit for a seat belt reminder system with a continuous or intermittent audible signal that does not cease until the seat belt is properly buckled (*i.e.,* after the 60 second FMVSS No. 208 minimum)? What data are available to support associated effectiveness? Are certain audible signal characteristics more effective than others?

(75) Is there an opportunity for including a seat belt interlock assessment in NCAP?

(76) If the Agency were to encourage seat belt interlock adoption through NCAP, should all interlock system approaches be considered, or only certain types? If so, which ones? What metrics could be evaluated for each? Should differing credit be applied depending upon interlock system approach?

(77) Should seat belt interlocks be considered for all seating positions in the vehicle, or only the front seats? Could there be an opportunity for differentiation in this respect?

(78) What information is known or anticipated with respect to consumer acceptance of seat belt interlock systems and/or persistent seat belt reminder systems in vehicles? What consumer interest or feedback data exist on this topic?

(79) Could there be an NCAP opportunity in a selectable feature that could be optionally engaged such as in the context of a ''teen mode'' feature?

(80) Should NHTSA take into consideration systems, such as intelligent speed assist systems, which determine current speed limits and warn the driver or adjust the maximum traveling speed accordingly? Should there be a differentiation between warning and intervention type intelligent speed assist systems in this consideration? Should systems that allow for some small amount of speeding over the limit before intervening be treated the same or differently than systems that are specifically keyed to a road's speed limit? What about for systems that allow driver override versus systems that do not?

(81) Are there specific protocols that should be considered when evaluating speed assist system functionality?

(82) What information is known or anticipated with respect to consumer acceptance of intelligent speed assist systems? What consumer interest or feedback data exist on this topic?

(83) Are there other means that the Agency should consider to prevent excessive speeding?

(84) If NHTSA considers this technology for inclusion in NCAP, are door logic solutions sufficient? Should NHTSA only consider systems that detect the presence of a child?

(85) What research data exist to substantiate differences in effectiveness of these system types?

(86) Are there specific protocols that should be considered when evaluating these in-vehicle rear seat child reminder systems?

(87) What information is known or anticipated with respect to consumer acceptance of integrated rear seat child reminder systems in vehicles? What consumer interest or feedback data exist on this topic?

VIII. Revising the 5-Star Safety Rating System

(88) What approaches are most effective to provide consumers with vehicle safety ratings that provide meaningful information and discriminate performance of vehicles among the fleet?

(89) Is the use of additional injury criteria/body regions that are not part of the existing 5-star ratings system appropriate for use in a points-based calculation of future star ratings? Some injury criteria do not have associated risk curves. Are these regions appropriate to include, and if so, what is the appropriate method by which to include them?

(90) Should a crashworthiness 5-star safety ratings system continue to measure a vehicle's performance based on a known or expected fleet average performer, or should it return to an absolute system of rating vehicles?

(91) Considering the basic structure of the current ratings system (combined injury risk), the potential overlapping target populations for crashworthiness and ADAS program elements, as well as other potential concepts mentioned in this document such as a points-based system, what would the best method of calculating the vehicle fleet average performance be?

(92) Should the vehicle fleet average performance be updated at regular intervals, and if so, how often?

(93) What is the most appropriate way to disseminate these updates or changes to the public?

(94) Should the Agency disseminate its 5-star ratings with half-star increments?

(95) Should the Agency assign star ratings using a decimal format in addition to or in place of whole- or half-stars?

(96) Should the Agency continue to include rollover resistance evaluations in its future overall ratings?

IX. Other Activities

(97) Considering the Agency's goal of maintaining the integrity of the program, should NHTSA accept self-reported test data that is generated by test laboratories that are not NHTSA's contracted test laboratories? If no, why not? If yes, what criteria are most relevant for evaluating whether a given laboratory can acceptably conduct ADAS performance tests for NCAP such that the program's credibility is upheld?

(98) As the ADAS assessment program in NCAP continues to grow in the future to include new ADAS technologies and more complex test procedures, what other means would best address the following program challenges: Methods of data collection, maintaining data integrity and public trust, and managing test failures, particularly during verification testing?

(99) What is the potential for consumer confusion if information on the Monroney label and on the website differs, and how can this confusion be lessened?

(100) What types of vehicles do consumers compare during their search for a new vehicle? Do consumers often consider vehicles with different body styles (*e.g.,* midsized sedan versus large sport utility)?

(101) When searching for vehicle safety information, do consumers have a clear understanding for which vehicles they are seeking information, or do they browse through vehicle ratings to identify vehicles they may wish to purchase?

(102) When classifying vehicles by body style, what degree of classification is most appropriate? For example, when purchasing a passenger vehicle, do consumers consider all passenger vehicles, or are they inclined to narrow their searches to vehicles of a subset

of passenger vehicles (*e.g.,* subcompact passenger vehicle)?

(103) Within the context of the updates considered in this notice, what is the most important top-level safety-related information that consumers should be able to compare amongst vehicles? Which of these pieces of information should consumers be able to use to sort and filter search results?

Appendix C. History of Relevant Events and Documents Pertaining to This Notice

A. April 5, 2013 Request for Comments

On April 5, 2013, NHTSA published an RFC notice [261] asking the public to ''help identify the potential areas of study for improvement to the program that have the greatest potential for producing safety benefits.'' Specifically, NHTSA requested comments on areas in which the Agency believed enhancements to NCAP could be made either in the short term or over a longer period of time. Several ADAS applications were discussed for possible future inclusion in the crash avoidance program in NCAP, including blind spot warning, lane keeping assistance, crash imminent braking, dynamic brake support, and pedestrian detection and intervention systems.

A total of 68 organizations or individuals submitted comments in response to the April 2013 notice. The comments received from stakeholders, though generally supportive of making improvements to NCAP's crash avoidance program by including assessment of additional ADAS technologies, exhibited disagreement about how and when a particular technology should be added to the program. Specifically, these disagreements included the conditions under which these technologies should be incorporated into NCAP.

Generally, most commenters supported the assessment of ADAS technologies, such as CIB, DBS, and rearward pedestrian detection, in NCAP. There was also support from commenters on the addition of pedestrian safety assessment in NCAP. However, opinions varied regarding whether an active and/or passive pedestrian safety program should be included in NCAP. Moreover, consumer demand for blind spot warning technology resulted in many commenters recommending the technology for inclusion in NCAP.

Many commenters encouraged NHTSA to ensure that any program area considered for inclusion in NCAP should have the necessary supporting data (*e.g.,* safety benefits) and address a safety need. Furthermore, many commenters (including both vehicle manufacturers and safety advocate groups) asked the Agency to also consider a regulatory, as well as a non-regulatory (NCAP) approach, for any vehicle safety improvements—especially regarding the introduction of new advanced crash test dummies. Vehicle manufacturers requested that the Agency consider providing sufficient lead time for implementation of any program update. Lastly, many commenters recommended harmonizing test procedures, test requirements, test devices, and the like with other government agencies and standards development organizations, such as the International Organization for Standardization (ISO), SAE International (SAE), and other consumer information programs worldwide.

B. January 28, 2015 Request for Comment and November 5, 2015 Final Decision

On January 28, 2015, in response to favorable feedback received on crash imminent braking (CIB) and dynamic brake support (DBS) through the 2013 RFC, NHTSA published an RFC proposing to add these technologies to NCAP.[262] On November 5, 2015, NHTSA issued the final decision to include these technologies, which became effective for model year 2018 vehicles.[263]

C. December 4, 2015 Fixing America's Surface Transportation Act

On December 4, 2015, the President signed the Fixing America's Surface Transportation (FAST) Act, which included a section that requires NHTSA to promulgate a rule to ensure crash avoidance information is displayed along with crashworthiness information on window stickers placed on motor vehicles by their manufacturers.[264] At the time the FAST Act was enacted, NHTSA was already in the process of developing an RFC notice to present many proposed updates to NCAP, including the evaluation of several new ADAS and a corresponding update of the Monroney label.

D. December 16, 2015 Request for Comments

On December 16, 2015, NHTSA published a broad RFC notice seeking comment on using enhanced tools and techniques for evaluating the safety of vehicles, generating star ratings, and stimulating further vehicle safety developments.[265] On the crashworthiness front, the RFC sought comment on establishment of a new frontal oblique test and use of the more advanced crash test dummies in all tests. The RFC also sought comment on creation of a new crash avoidance rating category and included nine advanced crash avoidance technologies. Additionally, the RFC sought comment on creation of a new pedestrian protection rating category involving the use of adult and child head, upper leg, and lower leg impact tests and two new pedestrian crash avoidance technologies. The RFC sought comment on combining the three categories into one overall 5-star rating.

In response to the notice, NHTSA received more than 300 comments, more than 200 of which were from individuals supporting comments made by the League of American Bicyclists. More than 30 individuals filed comments addressing a specific program area or several topics in the RFC.

The Agency also received responses to the notice at two public hearings, one in Detroit, Michigan, on January 14, 2016, and the second at the U.S. DOT Headquarters in Washington, DC, on January 29, 2016. By request, NHTSA also held several meetings with stakeholders.[266]

In response to the notice, commenters raised many issues involving both supporting data for the proposed changes and procedural concerns. Commenters stated that the public comment period was inadequate for purposes of responding because of the complexity of the program described in the RFC, and claimed that the technical information supporting the notice was not sufficient to allow a full understanding of the contemplated changes. According to the commenters, this hindered their ability to prepare substantive comments in response to the notice. In addition, most vehicle manufacturers stated that the significant cost burden associated with fitment of the proposed new technologies and the inclusion of a new crash test and new test dummies would increase the price of new vehicles. Manufacturers also noted that the advanced crash test dummies described in the RFC were not yet standardized and needed additional work. Manufacturers, along with safety advocates, further expressed the need for data demonstrating that each proposed program change would provide sufficient safety improvement to warrant its inclusion in NCAP. In addition, several commenters suggested that NHTSA develop near-term and long-term roadmaps for NCAP and revise NCAP in a more gradual, ''phased'' approach.[267]

E. October 1, 2018 Public Meeting

In response to the issues raised by those who commented on the December 2015 notice and in light of the FAST Act mandate [268] NHTSA issued a notice announcing its plan to host a public meeting to re-engage stakeholders and seek up-to-date input to help the Agency plan the future of NCAP. Interested parties were also able to submit written comments to the docket.[269]

Thirty-five parties participated in the public meeting, 32 of which submitted written comments to the docket. Additional written comments were submitted by others who did not attend the public meeting. These commenters included: Automobile manufacturers, consumer organizations, suppliers, industry associations, academia, individuals, and other organizations. A large

---

[261] 78 FR 20597 (Apr. 5, 2013).

[262] 80 FR 4630 (Jan. 28, 2015).

[263] 80 FR 68604 (Nov. 5, 2015).

[264] Section 24321 of the FAST Act, otherwise known as the ''Safety Through Informed Consumers Act of 2015.''

[265] 80 FR 78521 (Dec. 16, 2015).

[266] See *www.regulations.gov,* Docket No. NHTSA–2015–0119 for a full listing of the commenters and the comments they submitted, as well as records of the public hearings and smaller meetings relating to the RFC that occurred.

[267] For example, one commenter, the Alliance of Automobile Manufacturers, recommended ''that NHTSA revise NCAP in phases to maintain a data-driven, science-based foundation for the program by, in part, completing the standardization, federalization, and docketing of all ATDs and test fixtures to be used in NCAP.''

[268] Section 24322 ''Passenger Motor Vehicle Information'' of this Act requires the Secretary of the Department of Transportation to issue a rule no later than 1 year after the enactment of this Act ''to ensure that crash avoidance information is indicated next to crashworthiness information on stickers placed on motor vehicles by their manufacturers.''

[269] *https://www.regulations.gov,* Docket No. NHTSA–2018–0055.

number of individuals submitted comments requesting that NCAP account for pedestrians and bicyclists in its rating system, as members of the League of American Bicyclists.

Many commenters said an update to NCAP was taking too long. The prominent theme from the commenters included the request for an NCAP roadmap that lays out planned changes to the program and details when those changes are likely to occur. Some commenters pointed to the roadmaps of Euro NCAP. In addition, many of the comments focused on ADAS and the need for NCAP to stimulate further the incorporation of these technologies on vehicles. While supporting an overall rating, many commenters stated that the individual ratings for the crashworthiness and ADAS programs should be part of the new ratings system and be made available to consumers. Automaker commenters suggested that any changes to NCAP should allow adequate time for manufacturers to incorporate vehicle design changes in response to NCAP updates. Some commenters suggested that a vehicle's attributes and status following a crash (*e.g.,* notifying appropriate authorities) should be part of NCAP ratings as well.

Several commenters said changes to NCAP should be supported by sound science and data and address the safety problem with potential effectiveness of any countermeasure being rated. Some commenters also suggested that NCAP's promotion of ADAS technologies will lay the groundwork for automated driving systems (ADS). Several commenters suggested that there should be as much harmonization as possible with related global vehicle rating programs to minimize the cost and testing burden on vehicle manufacturers. Most commenters supported the idea that NHTSA continue to accept manufacturer-conducted, self-reported test results as evidence that the vehicles are equipped with one or more NCAP-recommended technologies (*i.e.,* that the Agency does not need to verify that the ADAS meet the NCAP system performance requirements).

Some commenters noted that NHTSA has yet to implement the requirement of the 2015 FAST Act to provide crash avoidance information on the Monroney label. Those who commented on this issue generally supported moving forward and completing this as soon as possible. A few additional commenters addressed the issue of possible new crash test dummies used in NCAP, but indicated that any new dummies should be ''Federalized'' by adding the dummies into 49 CFR part 572, ''Anthropomorphic test devices,'' before incorporating them into NCAP.

Regarding the dissemination and promotion of NCAP's vehicle safety information, some of the commenters urged the expanded use of new media and other technological approaches to communicating NCAP vehicle safety information. Others recommended that there should be traditional public information ''campaigns'' to make the public more aware of NCAP. Commenters requested a more robust search capability on NHTSA's website, particularly to facilitate consumer comparisons of vehicles within a class.

Among those addressing the utility and effectiveness of the 5-star ratings system, all supported the continued use of star ratings with some suggesting that the use of half-star increments would be a way to introduce more differentiation between vehicles and provide an incentive for manufacturers to improve vehicle safety in situations where doing so would result in an additional half star. One commenter suggested a 10-star rating system.

Comments were split on the question of whether new crash tests should be added to NCAP. Some supported adjusting the baseline injury risks associated with crashworthiness ratings. One commenter stated that NCAP should not pursue differentiation just for the sake of differentiation, instead suggesting that the highest priority should be to examine the correlation and validity of the current star rating system with real-world injury data. Several commenters suggested that there be a silver star rating as part of NCAP that would highlight safety aspects of vehicles that are of importance to older drivers. Others who commented on providing vehicle safety information for specific demographic groups either opposed the idea of information directed at demographic groups, expressed concerns, or said additional research is needed.

Issued in Washington, DC, under authority delegated in 49 CFR 1.95 and 501.5.

Steven S. Cliff,

Deputy Administrator.

[FR Doc. 2022–04894 Filed 3–8–22; 8:45 am]

BILLING CODE 4910–59–P