DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

[Docket No. NHTSA–2023–0020]

New Car Assessment Program

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

ACTION: Request for comments (RFC).

SUMMARY: This notice requests comment on a proposal to update the National Highway Traffic Safety Administration's New Car Assessment Program (NCAP) to provide consumers with information about crashworthiness pedestrian protection of new vehicles. The proposed updates to NCAP would provide valuable safety information to consumers about the ability of vehicles to protect pedestrians and could incentivize vehicle manufacturers to produce vehicles that provide better protection for vulnerable road users such as pedestrians. In addition, this proposal addresses several mandates set forth in section 24213 of the November 2021 Bipartisan Infrastructure Law, enacted as the Infrastructure Investment and Jobs Act.

DATES: Comments should be submitted no later than July 25, 2023.

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

- *Federal Rulemaking Portal: http://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 *http://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 *http://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:

Table of Contents

I. Executive Summary

The National Highway Traffic Safety Administration's (NHTSA) New Car Assessment Program (NCAP) provides comparative information on the safety performance of new vehicles and availability of new vehicle safety features to assist consumers with vehicle purchasing decisions and to encourage safety improvements. NCAP is one of several programs that NHTSA uses to fulfill its mission of reducing the number of fatalities, injuries, and economic losses that occur on United States (U.S.) roadways. This Request for Comments focuses on the inclusion of the first ever pedestrian protection program in U.S. NCAP.

While passenger vehicle occupant fatalities decreased from 32,225 in 2000 [1] to 23,824 in 2020,[2] during that same timeframe, pedestrian fatalities increased by 37 percent, from 4,739 in 2000 to 6,516 in 2020.[3] [4] These 6,516 pedestrian deaths in 2020 represent 17 percent of all traffic fatalities that year. In contrast, pedestrian injuries (54,769) were less than 3 percent of all motor vehicle occupant injuries (2,093,246) in 2020. Although vehicle-to-pedestrian crashes do not occur as frequently as vehicle-to-vehicle crashes, they are especially deadly. In fact, a NHTSA study that grouped various pre-crash scenarios into nine distinct pre-crash scenario groups,[5] including a group involving light vehicle [6] crashes with a pedestrian, estimated that on an annual

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

[2] Stewart, T. (2022, March). Overview of motor vehicle crashes in 2020 (Report No. DOT HS 813 266). National Highway Traffic Safety Administration.

[3] 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.

[4] Stewart, T. (2022, March). Overview of motor vehicle crashes in 2020 (Report No. DOT HS 813 266). National Highway Traffic Safety Administration.

[5] The nine pre-crash scenario groups are: control loss (vehicle lost control), road departure (vehicle departed road), animal (vehicle struck animal), pedestrian (vehicle struck pedestrian), pedalcyclist (vehicle struck pedalcyclist), lane change (vehicle made lane change), opposite direction (vehicle maneuvered into opposite direction), rear-end (vehicle struck rear of other vehicle), and crossing paths (vehicle traveled straight crossing another vehicle's path or turned and crossed another vehicle's path).

[6] Light vehicles include all passenger cars, vans, minivans, sport utility vehicles, or light pickup trucks with gross vehicle weight ratings less than or equal to 4,536 kilograms.

average, 53 of every 1,000 vehicle-to-pedestrian crashes is a fatal crash.[7] This fatality statistic in the light vehicle-pedestrian pre-crash scenario group is significantly greater than any of the other eight pre-crash scenario groups in the study.[8]

Historically, features rated or otherwise included in NCAP have focused largely on the protection of occupants in motor vehicles. However, NHTSA has also recognized the importance of protecting vulnerable road users, such as pedestrians, from injury and death due to motor vehicle crashes. In support of furthering the goal of protecting pedestrians from being seriously injured or killed in motor vehicle crashes, NHTSA has conducted a number of activities including research, international regulation development, and domestic regulation development.[9] On December 16, 2015, NHTSA published a broad request for comment (RFC) (the December 2015 Notice)[10] and sought public comment on the Agency's proposal that included, among other things, a new crashworthiness pedestrian protection testing program in NCAP. The December 2015 Notice proposed adding to NCAP test procedures and evaluation criteria similar to those used by the European New Car Assessment Programme (Euro NCAP) at the time to assess new vehicles for crashworthiness pedestrian protection performance.

In this RFC, NHTSA is proposing to add crashworthiness pedestrian protection to NCAP to spur vehicle technologies that help address the rising number of fatalities and injuries that involve pedestrians. NHTSA proposes to test vehicles using all four test devices currently utilized in Euro NCAP—adult and child headforms (representative of the weight of an adult and child head), the upper legform, and the FlexPLI lower legform.[11] The Agency is also proposing to adopt the majority of Euro NCAP's pedestrian crashworthiness assessment methods, including the injury limits for each test device and the method in which scores for each impact point are calculated. However, this RFC does not propose a comparative rating system for crashworthiness pedestrian protection. Instead, NHTSA is proposing to identify new model year vehicles that meet a certain minimum safety threshold on the Agency's website and in other published literature.

While the subject of this RFC also covers pedestrian protection, it should be viewed as a new initiative, not an extension of the December 2015 Notice. To this point, NHTSA noted in its March 9, 2022, NCAP RFC[12] that finalizing that 2022 RFC would close the December 16, 2015 proceeding and notice. The March 2022 NCAP RFC proposed adding four new advanced driver assistance systems (ADAS) technologies to those currently recommended in NCAP, increasing stringency of the evaluation of currently recommended ADAS technologies, and a ten-year roadmap of NHTSA's plans to upgrade NCAP in phases. NHTSA noted in the March 2022 notice that all information previously collected by NHTSA may be used in the development of future notices, such as this one. As such, this notice replaces the previous NCAP crashworthiness pedestrian protection proposal from the December 2015 RFC, in its entirety.

This proposal is part of the Agency's multi-faceted effort to encourage pedestrian safety improvements in vehicles by providing comprehensive vehicle safety information to consumers on (1) whether a vehicle can offer better protection to pedestrians in the event of a collision with a pedestrian and (2) whether a vehicle can prevent a collision with a pedestrian or reduce the severity of injuries to a pedestrian when equipped with advanced driver assistance systems such as pedestrian automatic emergency braking. The latter was proposed to be added to NCAP in the March 2022 RFC. In addition, NHTSA is working to issue a proposal mandating such systems in all new light vehicles. 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.[13] The Agency is also pursuing a rulemaking to set minimum safety standards for pedestrian protection.[14]

From a testing perspective, NHTSA still plans to align with, to the extent feasible, the Euro NCAP test procedures and evaluation criteria for pedestrian protection[15] for the Agency's new crashworthiness pedestrian protection testing program. However, in order to accelerate the adoption of pedestrian protection features into new vehicles, NHTSA is not proposing changes to the 5-star ratings system at this time.[16] As discussed in the notice that was published on March 9, 2022, NHTSA plans for multiple updates to NCAP in the next several years—as part of the Agency's short-term roadmap that will include various enhanced tools and techniques (advanced dummies, tests, rating systems, etc.) in both crashworthiness and crash avoidance programs. Until NHTSA completes a rulemaking to update the Monroney label, NHTSA plans to introduce the new crashworthiness pedestrian safety program in NCAP by highlighting on the NHTSA website new vehicles that meet NHTSA's performance test criteria for providing better pedestrian protection in the event of a collision with a pedestrian. NHTSA proposes using a pass/fail scoring system, described below, and will consider including pedestrian protection in the rating system when it updates the Monroney label.

The testing methodology proposed in this notice is very similar to that of Euro NCAP.[17] The pedestrian protection testing evaluates the potential risk of head, pelvis, leg, and knee injuries to pedestrians hit by the front of vehicles that result in impacts between the pedestrian and the bumper, leading edge, hood, and windshield of a vehicle. A vehicle that scores well in these tests will likely utilize designs that absorb

[7] 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). Table ES1—Yearly Average Statistics—Scenario Groups Based on 2011–2015 FARS and GES. Washington, DC. National Highway Traffic Safety Administration.

[8] The pre-crash scenario group ''Opposite Direction'' resulted in 32.3 fatal crashes per thousand crashes, the second highest. One of the lowest scenario groups was ''Rear-End,'' which only resulted in 0.7 fatal crashes per thousand crashes. On average, the nine scenario groups resulted in 4.9 fatal crashes per thousand crashes.

[9] *https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=202204&RIN=2127-AK98.*

[10] 80 FR 78522.

[11] The terms ''headform'' and ''legform'' are used to describe the pedestrian head and leg test devices, which are general representations of human heads and legs. The head and leg test devices are described in greater detail later in this notice.

[12] 87 FR 13452.

[13] *See https://www.transportation.gov/sites/dot.gov/files/2022-02/USDOT-National-Roadway-Safety-Strategy.pdf.*

[14] RIN 2127–AK98 available at *https://www.reginfo.gov/public/do/eAgendaViewRule?pubId=202204&RIN=2127-AK98.*

[15] Euro NCAP Pedestrian Testing Protocol—euro-ncap-pedestrian-testing-protocol-v85.201811091256001913.pdf (*euroncap.com*) and Part I Pedestrian Impact Assessment in *https://cdn.euroncap.com/media/67553/euro-ncap-assessment-protocol-vru-v1005.pdf.*

[16] Currently, the existing 5-star ratings system does not address pedestrian safety evaluation.

[17] *https://cdn.euroncap.com/media/41769/euro-ncap-pedestrian-testing-protocol-v85.201811091256001913.pdf.*

energy, reduce hard points of contact, and include front end shapes that would cause less harm (*i.e.,* injuries) to a pedestrian if a vehicle hits that pedestrian. The crashworthiness pedestrian protection test procedures in Euro NCAP consist of standardized instructions to (1) prepare a vehicle for testing, (2) conduct impact tests using various test devices, and (3) assess a vehicle's performance based on the result of the impact tests.

However, NHTSA plans to use a different scoring distribution than the one used in Euro NCAP. Specifically, for this proposal, the weightings are as follows: (1) the adult and child head impact test results would contribute ⅜ (37.5 percent) of the available points for a maximum component score of 13.5 points; (2) the upper leg impact test results would account for 2⁄8 (or 25 percent) of the available points for a maximum component score of 9 points; and (3) the lower leg impact test results would cover ⅜ (or 37.5 percent) of the available points for a maximum component score of 13.5 points. Also, NHTSA is proposing to award credit for pedestrian protection safety to vehicles that score 60 percent (21.6 out of 36.0 points) or above. Furthermore, NHTSA is proposing to implement this new program as a self-reporting program in which (1) vehicle manufacturers provide data to the Agency, (2) NHTSA reviews the data and awards credit as appropriate, and (3) NHTSA performs verification tests on certain new model year vehicles each year to ensure they meet the performance levels indicated by the vehicle manufacturer. A similar self-reporting and verification testing approach is currently used for evaluating certain ADAS technologies in NCAP.

This RFC fulfills portions of the requirements in Section 24213(b) of the Bipartisan Infrastructure Law, enacted as the Infrastructure Investment and Jobs Act [18] and signed on November 15, 2021, which require that the Agency ''publish a notice, for purposes of public review and comment, to establish a means for providing to consumers information relating to pedestrian, bicyclist, or other vulnerable road user safety technologies.'' [19]

Furthermore, NHTSA is committed to ensuring safety is equitable for all pedestrians, regardless of gender. The proposed test requirements cover the entire front end of the vehicle—the bumper, the grille, the hood leading edge, the hood, and the windshield—encompassing a large area causing injury to child and adult pedestrians in the real world. NHTSA believes that by covering such a large area, crash protection will be afforded to both male and female pedestrians of varying stature. Additionally, testing is conducted using two different headforms representing average child to adult heads.

The remainder of this notice outlines NHTSA's proposal in detail, including the self-reporting requirements and the process of conducting verification testing. Also, this notice describes in detail deviations from the Euro NCAP test procedures and requests public comment on the overall proposal as well as specific details of the proposal.

II. Background

NHTSA established the New Car Assessment Program (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, consumer interest in vehicle safety and manufacturers' attention to enhanced vehicle safety features was relatively new. Over the years, NCAP has periodically expanded the scope of the safety information the program provides to consumers. For example, the program added safety features to protect vehicle occupants involved in additional types of crashes, more specifically side impacts and rollovers. As more consumers focused on vehicle safety, making it a top factor in their vehicle purchasing decisions,[20] vehicle manufacturers responded to consumer demands by continually making safety improvements to their vehicles with enhanced safety features. These additional safety improvements have led to improved vehicle safety performance. This improvement in safety performance has translated into higher NCAP star ratings. In recent years, NHTSA has also incorporated various advanced driver assistance technologies in NCAP, including automatic emergency braking, and highlighted those technologies (via the Agency's website) if they meet NHTSA's system performance criteria. For the first time in the program's history, NHTSA is now, through this notice and the March 2022 RFC, taking steps to expand the program to also spur safety protection for those outside of the motor vehicle, with a particular focus on pedestrian safety.

A. December 16, 2015, Request for Comments

The Agency requested comment on broad, sweeping changes to NCAP in a December 2015 notice.[21] As part of that proposal, NHTSA outlined, among other things, details of a pedestrian protection safety rating category comprised of (1) pedestrian automatic emergency braking and (2) pedestrian crashworthiness. For pedestrian crashworthiness, the Agency proposed to evaluate how well a vehicle could reduce injuries sustained to a pedestrian in a frontal collision where the vehicle hit the pedestrian. The pedestrian crashworthiness impact tests proposed in the notice involved the use of adult and child headforms, an upper legform, and a FlexPLI lower legform.

The Agency received more than 300 comments in response to the December 2015 notice. The Agency also received responses to the notice at two public hearings, one in Detroit, Michigan, on January 14, 2016, and the second at U.S. DOT Headquarters in Washington, DC, on January 29, 2016. By request, the Agency also held several meetings with stakeholders.[22]

Regarding the Agency's pedestrian proposals, most commenters generally supported efforts to protect pedestrians using both pedestrian crash avoidance technologies and crashworthiness pedestrian safety. Commenters were divided on whether pedestrian crashworthiness should be applicable as a Federal Motor Vehicle Safety Standard (FMVSS) or if it was more appropriate for NCAP, even though the former application (*i.e.,* development of a FMVSS) was outside the scope of the RFC. Many commenters outlined technical issues with the pedestrian crashworthiness test devices and test procedures, with the majority of concern focused on the leg impactors. Furthermore, commenters noted that there were difficulties in meeting both 49 CFR part 581, ''Bumper Standard,'' and the proposed pedestrian crashworthiness requirements in NCAP. Commenters noted that some vehicles, such as sport utility vehicles (SUVs) and pickups, would have difficulty meeting pedestrian crashworthiness requirements due to their front-end geometry. Comments from vehicle manufacturers and suppliers generally supported the Agency's proposal to

[18] (Pub. L. 117–58).

[19] Further discussion on the BIL requirements appears in section II. Background, later in this notice.

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

[21] 80 FR 78521 (Dec. 16, 2015).

[22] See *http://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 ex parte meetings relating to the RFC that occurred.

harmonize with Euro NCAP pedestrian requirements. On the other hand, safety advocate organizations requested different test procedures and scoring from that in Euro NCAP to account for differences in vehicle fleets and promote new technology development.

Commenters were divided on how to implement pedestrian safety ratings in NCAP. Some commenters favored a separate pedestrian rating category that combines pedestrian crash avoidance and crashworthiness protection, while other commenters preferred a pedestrian safety assessment that splits into the crashworthiness protection category (*i.e.,* this proposal—vehicle performance evaluation for pedestrian protection) and the crash avoidance category (*i.e.,* pedestrian automatic emergency braking system performance evaluation for avoiding a collision with a pedestrian). As stated previously, some commenters supported crashworthiness pedestrian protection as part of an FMVSS instead of an NCAP rating.

B. October 1, 2018, Public Meeting

In 2018, NHTSA held a public meeting at the Department of Transportation's headquarters in Washington, DC to reengage stakeholders regarding potential changes to NCAP.[23] Thirty-five parties participated in the public meeting, 32 of which submitted written comments to the docket. Additional written comments were submitted by other entities or public citizens who did not attend.

In a notice announcing this meeting, NHTSA requested comments on a variety of topics, including both the crash avoidance and crashworthiness portions of the program. Although no pedestrian crashworthiness programs were proposed as part of the public meeting notice, nor were specific sessions of the public meeting targeted on pedestrian crashworthiness, several attendees and commenters suggested that the Agency continue to pursue pedestrian safety in NCAP. Specifically, a large number of individuals submitted comments supporting the League of American Bicyclists' comment that requested NHTSA to include pedestrians and bicyclists in the NCAP rating system.

Most commenters suggested 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 and stated that an update to the U.S. NCAP program was overdue.

[23] *https://www.regulations.gov,* Docket No. NHTSA–2018–0055.

C. Bipartisan Infrastructure Law and March 9, 2022, Request for Comments

Section 24213(b) of the Bipartisan Infrastructure Law includes requirements to add to NCAP information about advanced crash avoidance technologies and vulnerable road user safety. NHTSA is directed to publish an RFC to establish a means for providing consumers information relating to advanced crash avoidance technologies and pedestrian, bicyclist, or other vulnerable road user safety technologies.

For both advanced crash avoidance technologies and vulnerable road user safety, Section 24213(b) of the Bipartisan Infrastructure Law requires NHTSA to (i) determine which technologies shall be included, (ii) develop performance test criteria, (iii) determine distinct ratings for each technology, and (iv) update the overall vehicle rating to incorporate the new technology ratings in the public notices.

In March 2022, NHTSA published an RFC that proposed, among other things, adding four new ADAS technologies to NCAP, including Pedestrian Automatic Emergency Braking (PAEB). Because the March 2022 notice described in detail why NHTSA chose the four ADAS technologies for inclusion in NCAP, proposed performance test criteria for evaluating the technologies, and proposed PAEB for enhancing pedestrian safety as one of the four proposed ADAS technologies, NHTSA fulfilled requirements (i) and (ii) listed above of the Bipartisan Infrastructure Law Section 24213(b) for both advanced crash avoidance technologies and vulnerable road user safety. NHTSA anticipates finalizing the March 2022 proposal in a forthcoming notice. Adopting the changes proposed in the March 2022 notice would mark the first time in the history of NCAP that the program evaluates vehicle technologies that specifically target pedestrian safety, and thus could help address the rising number of fatalities and injuries that involve pedestrians.

Besides PAEB, there are other safety technologies to protect pedestrians. This notice describes crashworthiness pedestrian protection safety technologies and proposes their introduction into NCAP. Since this RFC seeks public comment on the inclusion of crashworthiness technologies for pedestrian protection into NCAP and the proposed performance tests and criteria to evaluate these technologies, it also fulfills parts (i) and (ii) listed above of Section 24213(b) of the Bipartisan Infrastructure Law with respect to vulnerable road user safety. The remaining requirements of section 24213(b) of the Bipartisan Infrastructure Law (iii and iv listed above) will be fulfilled once NHTSA proposes and then finalizes a new rating system for the crash avoidance technologies in NCAP, updates the current crashworthiness 5-star rating program, and proposes and finalizes an overall vehicle rating that incorporates crash avoidance and crashworthiness technology evaluations. Section 24213(b) of the Bipartisan Infrastructure Law also requires that NHTSA submit reports to Congress on its plans for fulfilling the abovementioned requirements. NHTSA plans to address these reporting requirements in a timely manner. In the March 2022 RFC, the Agency also sought public comment on a proposed ten-year roadmap outlining future updates to NCAP (mid-term and long-term timelines) in the next several years. A number of commenters noted that modern vehicles are larger, with higher front ends, and less visibility of non-occupants. These commenters expressed support for NHTSA's inclusion of crashworthiness pedestrian protection in the NCAP roadmap. Today's notice serves as the next step for the crashworthiness pedestrian protection update to NCAP.

III. Purpose and Rationale

This RFC carries out NHTSA's goals of improving pedestrian safety from a crashworthiness perspective and, in the process, partially fulfills section 24213(b) of the Bipartisan Infrastructure Law that requires the Agency to publish a request for comment notice to establish a means of providing consumers information relating to pedestrian, bicyclist, or other vulnerable road user safety technologies. Unlike the March 2022 RFC,[24] which focused on four advanced driver assistance systems, this notice focuses solely on the Agency's efforts to improve pedestrian safety from a crashworthiness perspective by evaluating how well a vehicle protects a pedestrian in the event of a frontal collision between the vehicle and the pedestrian. This RFC also works towards addressing recommendations from the National Transportation Safety Board (NTSB) and the Government Accountability Office (GAO).[25] [26]

[24] NHTSA's March 2022 RFC proposed four new ADAS technologies, including PAEB for improving pedestrian safety and therefore also partially addresses the Bipartisan Infrastructure Law Sec. 24213(b).

[25] NTSB Special Investigation Report—Pedestrian Safety (NTSB/SIR–18/03) Adopted September 25, 2018.

Continued

In particular, this notice seeks comment on a revised proposal to add pedestrian crashworthiness evaluations to NCAP. The Agency believes that the pedestrian crashworthiness test devices, test procedures, and evaluation criteria proposed in this RFC are well-established, and that incorporating pedestrian crashworthiness evaluations into NCAP has the potential to further reduce fatalities and injuries on U.S. roadways. Furthermore, by continuing to make safety information readily available to consumers, NHTSA hopes to increase consumer awareness of pedestrian safety issues.

The Agency includes numbered questions in this notice to highlight specific topics on which the Agency seeks comment. To ensure that NHTSA addresses all comments, the Agency requests that commenters provide corresponding numbering in their responses. The questions are compiled for the reader's convenience in appendix C.

IV. Crashworthiness Pedestrian Protection Testing Program

NHTSA currently conducts testing for NCAP in two different ways. The NCAP crashworthiness safety ratings program conducts physical crash tests with anthropomorphic test devices (ATDs, or crash test dummies), determines injury values based on ATD sensors, and assigns star ratings based on the resulting injury values. The NCAP crash avoidance safety testing program highlights vehicles equipped with certain advanced driver assistance system technologies (recommended by NHTSA through NCAP) if the vehicles meet NHTSA's system performance test criteria. Unlike the NCAP crashworthiness safety program, the crash avoidance safety program uses test data reported by vehicle manufacturers to determine whether a vehicle meets system performance criteria set forth under NCAP and awards credit as applicable. Each year, a certain number of advanced driver assistance systems are selected and tested to verify system performance as part of the NCAP crash avoidance safety testing program.

NHTSA's 2015 proposal for the crashworthiness pedestrian safety program was similar to that of the NCAP crashworthiness safety testing program. Vehicles would undergo physical testing with test devices (head and leg impactors), NCAP would determine injury values from the test devices' sensors, and the program would then assign star ratings based on the test results.

Today's proposal would operate more similarly to the NCAP crash avoidance safety testing program than the crashworthiness program. Under the proposal, NHTSA would collect voluntary self-reported data from vehicle manufacturers. If a vehicle manufacturer submits self-reported data for its vehicle, NCAP would first review data for accuracy and completeness and award credit where applicable. In addition, NHTSA would perform verification testing on a number of vehicles selected each year through NCAP. Instead of rating vehicles on a scale of 1 to 5 stars, the Agency plans to initially implement this program in NCAP by awarding pedestrian crashworthiness credit to vehicles that meet NHTSA's performance test criteria. This change from NHTSA's 2015 proposal will provide consumers the crashworthiness pedestrian safety information sooner rather than later as the Agency is working on other initiatives (discussed in the March 2022 proposals) to allow for a complete overhaul of the existing rating system in the future. More specifically, once NHTSA completes its planned updates to the NCAP crashworthiness and crash avoidance programs and concludes the Agency's ongoing consumer research for a new NCAP labeling concept on the Monroney label, NHTSA plans to update its safety ratings system to include pedestrian safety information. In the meantime, NHTSA believes that the proposal in this notice would provide consumers with valuable information and continue to incentivize vehicle safety improvements to help protect pedestrians.

The test procedures and evaluation criteria proposed in this RFC would make use of four pedestrian test device impactors—an adult headform, a child headform, an upper legform, and a FlexPLI lower legform. NHTSA proposes to carry out testing in the manner described in the Euro NCAP pedestrian test protocols, with some differences that will be explained in detail later in this notice.[27] Vehicles are first prepared by measuring and marking the front end of the vehicle in a prescriptive way to locate the test boundaries and impact points on the vehicle. The impact points are marked on a 100 mm by 100 mm grid on the hood, windshield, and surrounding components for the head impact tests; in a line along the hood (or bonnet) leading edge every 100 mm for the upper leg impact tests; and in a line along the front bumper every 100 mm for the lower leg impact tests. The test procedures then provide instructions on how to prepare and launch the test devices at the predetermined impact points—specifically, the adult and child headforms for the hood and windshield area points, the Transport Research Laboratory (TRL) upper legform for the hood leading edge points, and the Flexible Pedestrian Legform Impactor (FlexPLI) for the lower leg impact points. Finally, the procedures describe how a vehicle is scored and rated based on the resulting measurements collected from each impact test.

NHTSA believes that crashworthiness pedestrian protection is a suitable candidate for inclusion in NCAP because it satisfies four prerequisites the Agency previously established for inclusion of new safety programs in NCAP. 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 vehicle designs have safety benefit potential; and (4) a performance-based objective test procedure exists that can assess vehicle performance.[28]

A. Safety Need

In NHTSA's December 2015 RFC, the Agency outlined the safety need to upgrade NCAP with crashworthiness pedestrian protection. In that notice, NHTSA noted that over 4,000 motor-vehicle related pedestrian fatalities and 70,000 pedestrian injuries have occurred annually since the Agency began tracking these data in 1975.

Since that RFC was published in 2015, the number of pedestrians killed or injured in motor vehicle traffic crashes continued to grow. In fact, over the past 10 years (as shown in Table 1), motor vehicle related pedestrian fatalities in the U.S. have increased more than 46 percent—from 4,457 fatalities in 2011 to 6,516 fatalities in 2020. In the same time period, the proportion of pedestrians killed in motor vehicle crashes relative to all roadway crash fatalities increased from 14 percent to 17 percent, respectively.[29] [30]

[26] GAO Report—Pedestrian Safety (GAO–20–419), April 2020.

[27] *https://www.euroncap.com/en/for-engineers/protocols/vulnerable-road-user-vru-protection/.* See ''Pedestrian Test Protocol'' and Part I of the ''Assessment Protocol—VRU.'' Part II of the ''Assessment Protocol'' and the ''AEB VRU Test Protocol'' do not apply and are not part of this proposal.

[28] 78 FR 20599 (Apr. 5, 2013).

[29] National Center for Statistics and Analysis. (2021, May). Pedestrians: 2019 data (Traffic Safety Facts. Report No. DOT HS 813 079).

[30] Stewart, T. (2022, March). Overview of motor vehicle crashes in 2020 (Report No. DOT HS 813

TABLE 1—PEDESTRIAN FATALITIES BY YEAR

Year	Total fatalities	Pedestrian fatalities	
		Number	Percentage of total fatalities
2011	32,479	4,457	14
2012	33,782	4,818	14
2013	32,893	4,779	15
2014	32,744	4,910	15
2015	35,484	5,494	15
2016	37,806	6,080	16
2017	37,473	6,075	16
2018	36,835	6,374	17
2019	36,355	6,272	17
2020	38,824	6,516	17

Note: 2011–2018 data are from DOT HS 813 079 and 2019–2020 data are from DOT HS 813 266.

Motor vehicle related crashes involving pedestrians are especially deadly. Although they do not occur as frequently as crashes involving only motor vehicles, they result in fatalities more frequently. A 2019 NHTSA report examined the critical event and specific vehicle movements just prior to crashes that occurred from 2011 to 2015.[31] The report defined 36 distinct pre-crash scenarios arranged into nine groups, which accounted for 94 percent of fatal crashes. The pre-crash scenarios were grouped in terms of environmental conditions, road geometry, crash location, vehicle/crash-related factors, driver characteristics, attempted avoidance maneuver, traffic violations, and crash contributing factors. One of the pre-crash scenario groups studied was ''pedestrian,'' in which each crash included in this group involved at least one light vehicle (*i.e.,* less than 4,536 kilograms gross vehicle weight rating (GVWR)) striking a pedestrian. The report found an average of 3,731 fatal crashes and a total of 70,461 crashes a year included the critical event of a vehicle striking a pedestrian—as shown in Table 2. Although 70,461 crashes represent only one percent of all crashes, 3,731 fatal crashes represent 15 percent of all fatal crashes. This represents 53 fatal crashes per thousand crashes, the highest among any pre-crash scenario group identified in the report.

TABLE 2—NINE SCENARIO GROUPS YEARLY AVERAGE BASED ON 2011–2015 FARS AND GES

Scenario group	Crashes where the light vehicle is making the critical action						Number of fatal crashes per 1,000 crashes
	Fatal crashes		All crashes		Number of crashes per billion light vehicle miles traveled		
	Total	%	Total	%	Fatal	All	
1. Control Loss	4,456	18%	470,733	9%	1.6	174	9.5
2. Road Departure	6,500	26	547,098	11	2.4	202	11.9
3. Animal	102	0	297,968	6	0.0	110	0.3
4. Pedestrian	3,731	15	70,461	1	1.4	26	53.0
5. Pedalcyclist	518	2	47,927	1	0.2	18	10.8
6. Lane Change	752	3	644,099	13	0.3	238	1.2
7. Opposite Direction	3,258	13	100,786	2	1.2	37	32.3
8. Rear-End	1,245	5	1,709,717	34	0.5	632	0.7
9. Crossing Paths	3,972	16	1,131,273	23	1.5	418	3.5
Nine Group Total	24,534	100	5,020,062	100	9.1	1,855	4.9

Most pedestrian traffic motor vehicle related fatalities are due to a collision with a single-vehicle (under 4,536 kilograms GVWR) where the impacting point is the front of the vehicle. Between 2011 and 2020, 55,775 pedestrians were killed in motor vehicle crashes.[32] Of these pedestrians, 71.8 percent (40,093) were killed by light vehicles (*i.e.,* passenger cars, pickups, SUVs, and vans under 4,536 kilograms GVWR) in single-vehicle crashes.[33] Ninety percent (36,076) of the aforementioned single-vehicle crashes were frontal impacts.[34] Passenger cars were responsible for approximately half (18,194) of these 36,076 fatalities, and light trucks (*i.e.,* SUVs, pickups, and vans) were responsible for the other half (17,882).[35] Large trucks and buses over 4,536 kilograms GVWR in single-vehicle crashes with pedestrians accounted for a much smaller portion of single vehicle pedestrian fatalities; about 7 percent (3,388).[36]

In addition to fatalities that occur in traffic motor vehicle-to-pedestrian crashes, there are notable numbers of nonoccupants killed and injured in non-traffic motor vehicle related crashes. Non-traffic crashes frequently occur in private roadways, parking facilities, and driveways, places in which NHTSA's

266). National Highway Traffic Safety Administration.

[31] 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.

[32] See Table 16 in appendix A.

[33] See Table 17 in appendix A.

[34] See Table 18 in appendix A.

[35] See Table 18 in appendix A.

[36] See Table 17 in appendix A.

Fatality Analysis Reporting System (FARS) and Crash Report Sampling System (CRSS) data systems do not capture data. NHTSA's Non-Traffic Surveillance (NTS) system recorded an average additional 386 nonoccupants killed and 14,265 injured annually from forward-moving vehicles between 2016 and 2020.[37] These average annual numbers are similar to data collected through the NTS in 2012–2015.[38 39] Although the data may include some non-pedestrian nonoccupants (such as bicyclists), it highlights the dangers of moving motor vehicles to nonoccupants around them, even in lower speed environments outside of roadways.

B. System Designs Exist

As discussed in the 2015 NCAP RFC, the Agency selected the speed of 40 kph (25 mph) for testing in the NCAP crashworthiness pedestrian protection program because most pedestrian crashes occur at this speed or below. Thus, there is opportunity to improve pedestrian safety. In crashes that occur at these speeds—up to 40 kph (25 mph), for low profile vehicles such as passenger cars—the typical pedestrian-vehicle interactions are as follows: (1) the pedestrian's lower legs generally engage with the vehicle bumper, (2) the upper leg and pelvis make contact with the vehicle's leading edge, (3) the body is rotated around the vehicle and the torso swings downward, and (4) the pedestrian's head makes contact with the vehicle's hood or windshield. Higher-profile vehicles, such as large SUVs, vans, and trucks, may engage with the pedestrian's pelvis earlier in the dynamic event. At speeds greater than 40 kph (25 mph), impact dynamics often cause the pedestrian's head to overshoot the hood and windshield and therefore countermeasures become less relevant to reduce head injuries to pedestrians.

The fatalities and serious injuries that occur from motor vehicle crashes involving pedestrians can be attributed to specific body regions. A NHTSA study using both U.S. and German crash data found that the head and lower extremities are the most common injury locations on a struck pedestrian.[40] For seriously-injured pedestrians (Abbreviated Injury Scale (AIS) 3 or higher), the thorax is the third most common body location to sustain an injury.[41] For disabling injuries, where the pedestrian is still disabled one year after the crash, the thorax injury is less prevalent, and the pelvis/hip area is the third most common body location injured.[42] Thus, the head, legs, and thorax are the most common locations of serious injury, and the head, legs, and pelvis/hip are the most common locations for disabling injuries.

The same NHTSA study also showed that pedestrian injuries sustained to the body regions mentioned above can be primarily attributed to areas of the impacting vehicle. For instance, the bumper and valence[43] of a vehicle are responsible for the majority of serious and disabling injuries caused primarily to the lower legs. Also, the hood (or bonnet) of a vehicle is the cause of injuries to numerous areas of the body including the head and face, thorax, upper extremities, abdomen, and pelvis and hip. Furthermore, the hood leading edge is a significant source of injuries to the thorax and pelvis and hip, especially in larger vehicles. Finally, the windshield of a vehicle is the second highest source of injury—just behind the bumper, and the leading cause of head injuries.

Vehicles can be designed to mitigate injury to a pedestrian for the body areas discussed above. For example, a vehicle's bumper and hood leading edge can be designed to have geometric and material properties to minimize bending moments and ligament extension in a pedestrian's leg and knee or excessive force in the pelvis and hip. Similarly, the hood may be designed to have space underneath to crush without bottoming out on any rigid components, such as an engine block. The hood and hood hinges may also be designed in a way to make them less rigid and to allow more deformation when impacting a pedestrian. The deformation of components on a vehicle would absorb some of the energy of the impact and transfer less energy to the pedestrian's head—thus lessening the chance of a head injury. Certain vehicles are even designed with an active hood that deploys upon contact with a pedestrian to allow more space between the hood and engine bay components for additional deformation and energy absorption.

Since other consumer information vehicle safety programs such as The European New Car Assessment Programme (Euro NCAP), The Australasian New Car Assessment Program (ANCAP), Japan New Car Assessment Program (JNCAP), and Korean New Car Assessment Program (KNCAP) have been evaluating crashworthiness pedestrian protection over the years, vehicles with pedestrian safety countermeasures have been available in the market globally. In preparation for incorporating the crashworthiness pedestrian protection program in U.S. NCAP, NHTSA surveyed vehicles in the U.S. fleet by conducting a feasibility study on nine model year (MY) 2015–2017 vehicles to evaluate their pedestrian protection performance against the Euro NCAP test procedures.[44] The nine vehicles included pickups, SUVs, and passenger cars, domestic-only models and global platform[45] vehicles that are not only sold in the U.S. but also are available in other markets with minor design changes. As shown in Table 3, four of the tested vehicles exceeded the 60 percent score necessary to receive a 5-star overall rating in Euro NCAP.[46] Four of the vehicles scored under the 60 percent threshold, and one vehicle received a 60 percent score. In general, the global platform vehicles were found to perform better overall in the pedestrian impact tests (using the Euro NCAP test procedures) than the domestic-only models. This study

[37] National Center for Statistics and Analysis. (2022, September). Non-Traffic Surveillance: Fatality and injury statistics in nontraffic crashes, 2016 to 2020. (Report No. DOT HS 813 363). National Highway Traffic Safety Administration.

[38] Singh, S. (2016, August). Non-Traffic Surveillance: Fatality and injury statistics in non-traffic crashes, 2012 to 2014. (Report No. DOT HS 812 311).

[39] National Center for Statistics and Analysis. (2018, April). Non-traffic surveillance: fatality and injury statistics in nontraffic crashes in 2015 (Traffic Safety Facts. Report No. DOT HS 812 515).

[40] Mallory, A., Fredriksson, R., Rosen, E., Donnelly, B. (2012, October). Pedestrian Injuries By Source: Serious and Disabling Injuries in US and European Cases. 56th AAAM Annual Conference.

[41] 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).

[42] Disabling injuries were estimated using the Functional Capacity Index (FCI). In the FCI system, each AIS code is assigned an FCI value to reflect the expected disability one year following the injury for initially healthy adults between the ages of 18 and 34.

[43] The valence is a thin panel located under the bumper that is generally used as a styling element, to improve aerodynamics, or to protect the underside of the vehicle.

[44] Suntay, B., Stammen, J., & Martin, P. (2019, June). Pedestrian protection—Assessment of the U.S. vehicle fleet (Report No. DOT HS 812 723). Washington, DC: National Highway Traffic Safety Administration.

[45] Global platform vehicles are vehicles that have variants sold in both the U.S. and European markets.

[46] For MY2022, vehicles must receive a vulnerable road user sub-score of 60 percent or greater to be eligible to receive a 5-star overall rating in Euro NCAP. Euro NCAP's vulnerable road user sub-score also includes active crash avoidance systems, such as PAEB, that were not factored into NHTSA's crashworthiness only assessment of pedestrian protection.

shows that not only can vehicles in the U.S. market be designed with pedestrian safety in mind, but also additional safety gains can be made for currently underperforming vehicles through better vehicle designs.

TABLE 3—U.S. FLEET VEHICLES TESTED USING EURO NCAP SCORING METHODOLOGY

Vehicle	Scores (max 36 pts)	Percentage
2017 Audi A4 *	24.41	67.8%
2016 Chevrolet Malibu	21.75	60.4
2016 Chevrolet Tahoe	14.98	41.6
2016 Ford Edge *	18.60	51.7
2015 Ford F–150	11.02	30.6
2016 Honda Fit *	24.67	68.5
2016 Nissan Rogue *	30.00	83.3
2016 Toyota Prius *	30.12	83.7
2015 Toyota Sienna	19.10	53.1

* Global platform vehicles with European variants tested by Euro NCAP

C. Potential Safety Benefits

While pedestrian fatalities have been increasing in the U.S. in recent years, there has been a steady decline in pedestrian fatalities in other developed countries. Figure 1 shows that pedestrian fatalities related to motor vehicle crashes significantly decreased in Europe and gradually decreased in Japan—especially from 2000 to 2010. Pedestrian fatalities in the U.S., on the other hand, remained the same during that time period but then steadily increased over the past ten years and at a much faster pace for several years now. One difference between the other countries in Figure 1 and the U.S. is that other countries have adopted crashworthiness pedestrian protection vehicle safety consumer information programs and pedestrian protection regulations, while the U.S. has not yet adopted either.

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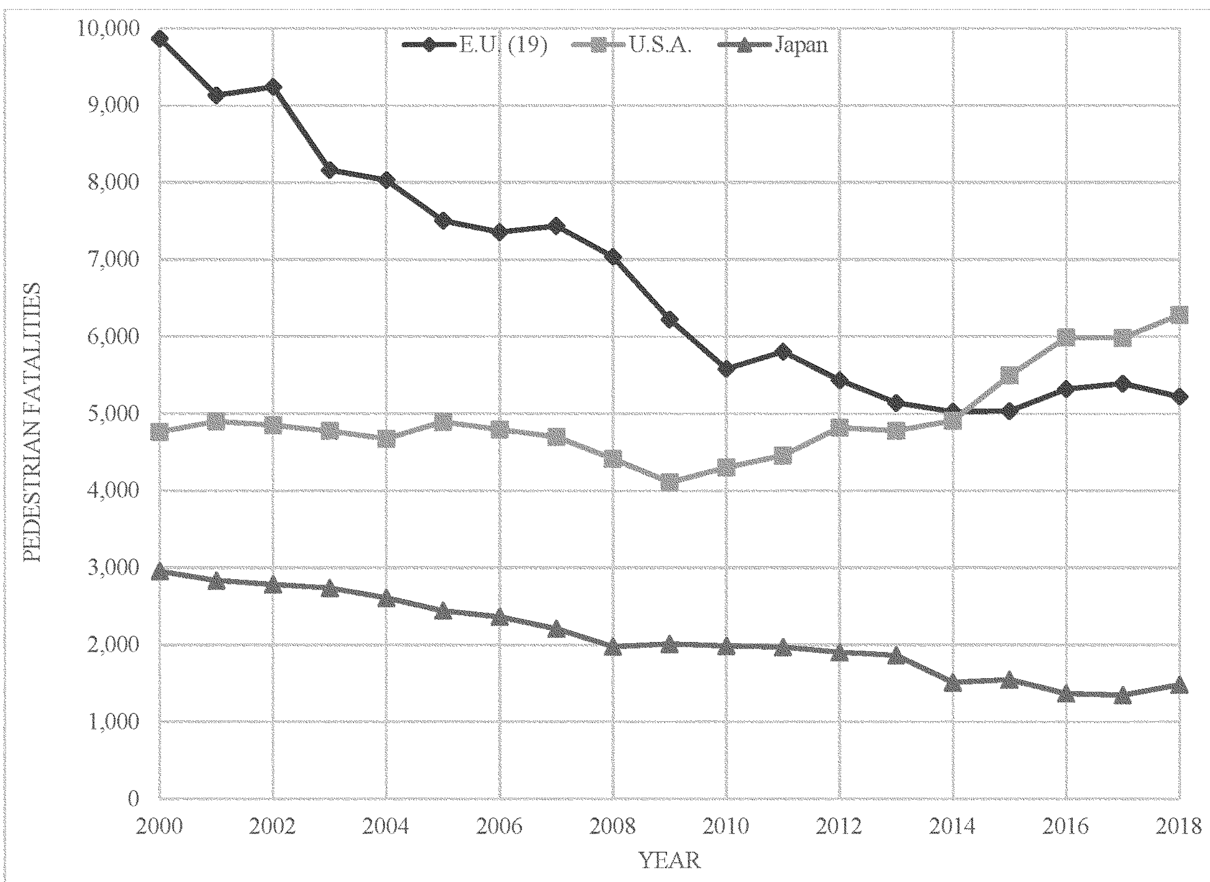

Figure 1: Pedestrian Fatalities in the U.S., European Union, and Japan[47]

[47] Sources: FARS (U.S.), European Road Safety Observatory (E. U.), Institute for Traffic Accidents Research and Data Analysis (Japan)

As discussed previously, other consumer information vehicle safety programs have implemented various crashworthiness pedestrian protection testing programs over the years. A paper published by the German Federal Highway Research Institute (BASt) studied the effectiveness of crashworthiness pedestrian protection requirements in Germany.[48] By examining crash data from Germany, this paper found a correlation between Euro NCAP pedestrian protection scores and pedestrian injuries and fatalities. The author concluded that ''each point in [the Euro] NCAP [pedestrian] score relates to a relative reduction in probability of 2.5 percent for fatalities, and 1 percent for serious injuries.'' Similarly, a paper published by the Swedish Transport Administration found vehicles that scored better in the Euro NCAP pedestrian crashworthiness tests produced less serious injuries in real-world crashes.[49]

The DOT believes that the crashworthiness pedestrian protection tests outlined in this proposal have the potential to reduce the rising number of pedestrian fatalities and injuries in the U.S. As discussed previously, there were 36,076 pedestrian fatalities between 2011–2020 involving single-vehicle crashes between the front end of a light vehicle and a pedestrian.[50] When travel speed was known, 13.2 percent of fatal crashes occurred at travel speeds of 40 kph (25 mph) or below (Figure 2).[51] From 2011–2020, the front end of passenger cars and light trucks caused approximately 479,000 injuries to pedestrians in single-vehicle crashes,[52] and 68.7 percent of those crashes occurred at travel speeds of 40 kph (25 mph) and below when travel speed was known.[53] Looking at these data on an annual basis, approximately 476 fatalities and 32,907 injuries could be mitigated by crashworthiness pedestrian protection contemplated under the proposed testing program. Based on this data, the DOT believes that the proposed test speed of 40 kph (25 mph) is an appropriate threshold for the new crashworthiness pedestrian protection tests in NCAP.

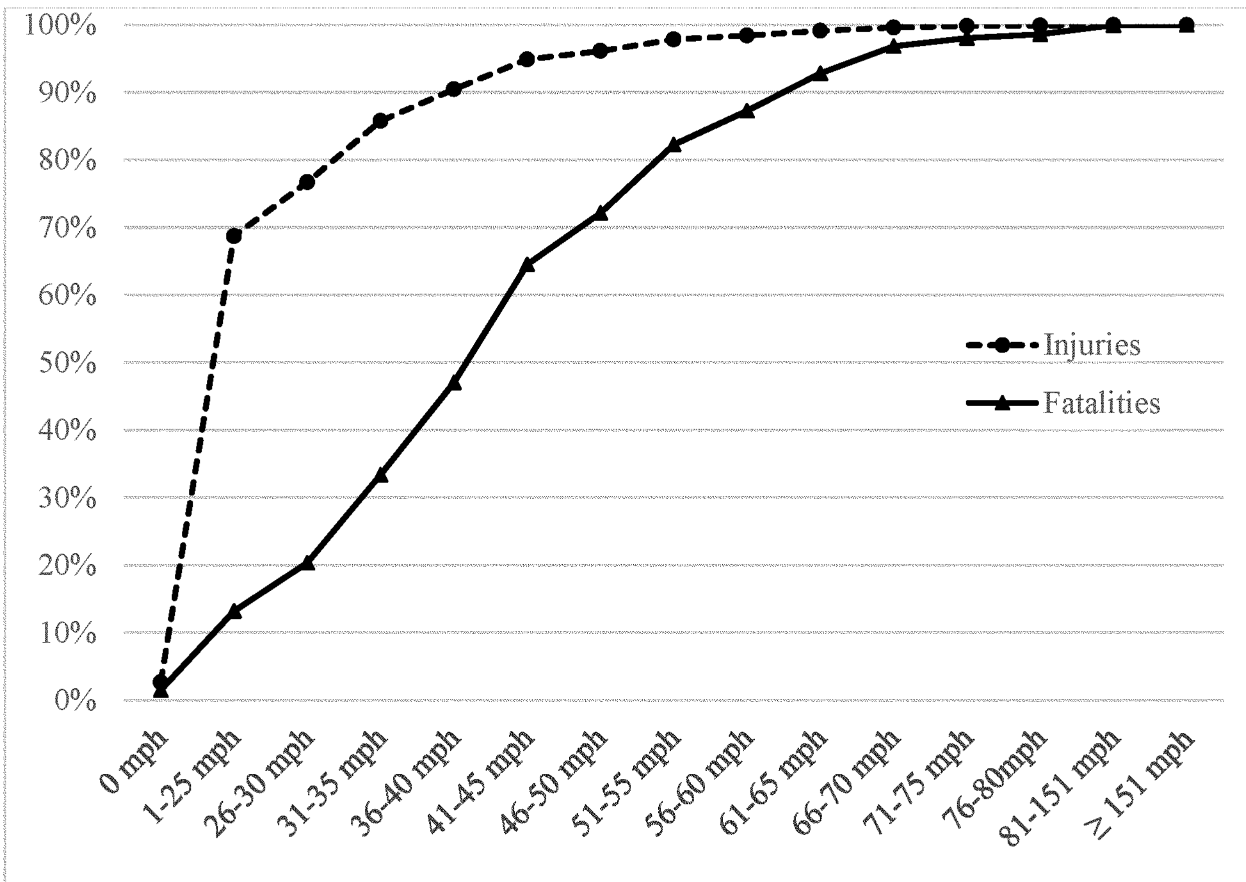

Figure 2: Cumulative Pedestrian Injuries and Fatalities in the U.S. by Travel Speed 2011-2020

Source: FARS and GES

[48] Pastor, C., ''Correlation between pedestrian injury severity in real-life crashes and Euro NCAP pedestrian test results,'' The 23rd International Technical Conference on the Enhanced Safety of Vehicles, Paper No. 13–0308, 2013.

[49] Standroth, J. et al. (2014), ''Correlation between Euro NCAP pedestrian test results and injury severity in injury crashes with pedestrians and bicyclists in Sweden,'' Stapp Car Crash Journal, Vol. 58 (November 2014), pp. 213–231.

[50] See Table 18 in appendix A.

[51] See Table 19 in appendix A.

[52] See Table 20 in appendix A.

[53] See Table 19 in appendix A.

Although these numbers only account for crashes occurring at 40 kph (25 mph) or less, it is possible that some residual benefit could also be afforded in crashes that occur at slightly higher speeds. Furthermore, as PAEB continues to proliferate in the vehicle fleet, it is expected that vehicles traveling at speeds above 40 kph (25 mph) may impact pedestrians as it slows down to speeds at or below 40 kph (25 mph) if the PAEB system engages but is unable to fully stop the vehicle. Thus, crashworthiness pedestrian protection countermeasures along with PAEB technology may provide pedestrians some safety benefit even at higher speeds, either by avoiding pedestrian collision or by reducing the impact speeds to levels at which crashworthiness pedestrian protection countermeasures would work.

D. Objective Test Procedure Exists

The last guiding principle in NHTSA's four pre-requisites when considering a new safety program for inclusion in NCAP is whether there is an objective test procedure to assess for vehicle performance. NHTSA has been conducting research, developing test devices, and creating test procedures to simulate pedestrian crash impacts since the 1980s. As early as 1990, NHTSA published a test procedure for evaluating head impacts to the hood of a test vehicle.[54] Some of the elements of the early test procedures are still used in these currently proposed pedestrian crashworthiness test procedures, such as the use of an adult and child headform to measure head injury criteria (HIC), the layout of test locations on the hood of a test vehicle, test speeds at 40 kph (25 mph), and the concept of a "wrap around distance" (WAD)—as shown in Figure 3.[55]

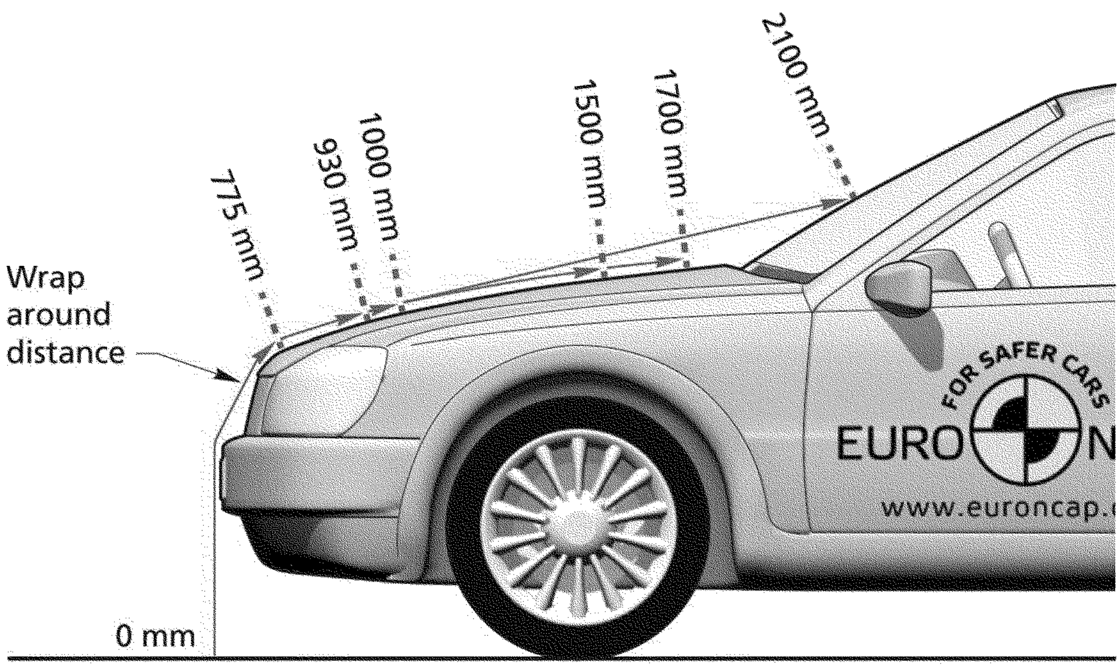

Figure 3: Wrap Around Distance (WAD)[56]

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Over the years, many advancements to pedestrian crashworthiness evaluations have occurred in part due to the introduction of similar pedestrian safety programs in other NCAP programs worldwide. For instance, in addition to using the headforms for head injury assessment, other impactors such as the legforms that measure forces, bending moments, and ligament elongation for the knees have been developed. Test devices have also undergone design changes to improve biofidelity and durability. Furthermore, the test zone is no longer limited to just the central portion of the hood as it has been extended to other areas on a vehicle such as the front bumper, hood leading edge, windshield, and A-pillars, to include assessment of other injury sources to pedestrians. Also, test procedures have been refined to ensure that the layout of test points and the aiming method of test impactors are more repeatable. Most of NHTSA's recent research activities on crashworthiness pedestrian safety may be found in *http://www.Regulations.gov* (Docket Number: NHTSA–2019–0112), and additional work is published on the National Transportation Library website with the search keywords "Pedestrian Safety." [57] [58] DOT notes that some documents contained in these repositories do not directly relate to this proposal to update NCAP.

Table 4 through Table 8 summarize the various crashworthiness pedestrian protection testing programs being

[54] MacLaughlin, T. and Kessler, J., "Pedestrian Head Impact Against the Central Hood of Motor Vehicles—Test Procedure and Results," SAE Technical Paper 902315, 1990.

[55] The term "Wrap Around Distance (WAD)" is a distance measurement made using a flexible tape measure. One end of the tape is held at ground level directly below the bumper. The other end is wrapped around the front end of a vehicle and held taut and in contact with a point on the hood or windshield.

[56] Copyright Euro NCAP 2018. Reproduced with permission from Euro NCAP Pedestrian Testing Protocol V8.5 Figure 9.

[57] *Regulations.gov* docket available here: *https://www.regulations.gov/docket/NHTSA-2019-0112.*

[58] *https://rosap.ntl.bts.gov/gsearch?pid=dot%3A40796&parentId=dot%3A40796&sm_key_words=Pedestrian%20safety.* Search keywords "pedestrian safety".

conducted around the world. The tables display both consumer information programs (NCAPs) as well as regulations. Global Technical Regulation No. 9 Pedestrian Safety[59] is the basis for the regulation adopted in Europe—UNECE R127;[60] the regulation adopted in Korea—Korean Motor Vehicle Safety Standard 102–2; and the regulation adopted in Japan—Article 18 Attachment 99. The purpose of the consumer information programs is to provide information to new vehicle buyers and often incentivize safety improvements that extend beyond the established standards, while the purpose of the regulations is to set minimum performance standards. Therefore, the consumer information programs award zero points for tests that do not meet certain established performance criteria.

TABLE 4—ADULT HEADFORM TEST COMPARISON

	Consumer information programs				GTR 9 and UN R127 and KMVSS 102–2 and Japan article 18 att. 99
	Euro NCAP and ANCAP	JNCAP	KNCAP	C–NCAP	
Impact Velocity (kph)	40	40	40	40	35
WAD (mm)	* 1500/1700–2100	1700–2100	1700–2100	1500/1700–2300	1700–2100
Impact Angle (degrees)	65	65	65	65	65
Test on windshield?	Yes	Yes	Yes	Yes	No
HIC Max. Score	650	650	650	650	
HIC Zero Score	1700	1700	1700	1700	
HIC Limit					1000/1700

* In Euro NCAP and ANCAP, points rearward of the bonnet rear reference line between 1500 mm and 1700 mm WAD and up to 2100 mm WAD are assessed using the adult impactor.

TABLE 5—CHILD HEADFORM TEST COMPARISON

	Consumer information programs				GTR 9 and UN R127 and KMVSS 102–2 and Japan article 18 att. 99
	Euro NCAP and ANCAP	JNCAP	KNCAP	C–NCAP	
Impact Velocity (kph)	40	40	40	40	35
WAD (mm)	* 1000–1500/1700	1000–1700	1000–1700	1000–1500/1700	1000–1700
Impact Angle (degrees)	50	50	50	50	50
Test on windshield?	Yes	Yes	Yes	Yes	No
HIC Max. Score	650	650	650	650	
HIC Zero Score	1700	1700	1700	1700	
HIC Limit					1000/1700

* In Euro NCAP and ANCAP, where the bonnet rear reference line is between 1500 mm and 1700 mm WAD, points forward of and directly on the BRRL are assessed using the child headform. Where the BRRL is rearward of 1700 mm WAD, the child headform is used up to and including 1700 mm.

TABLE 6—UPPER LEGFORM TO WAD775 TEST COMPARISON

	Consumer information programs				GTR 9 and UN R127 and KMVSS 102–2 and Japan article 18 att. 99
	Euro NCAP and ANCAP	JNCAP	KNCAP	C–NCAP	
Impact Angle (°)	90° leading edge.				
Impact Velocity (kph)	20–33.				
Sum of forces (N) Max. Score	5000.				
Sum of forces (N) Zero Score	6000.				
Bending moment (Nm) Max. Score	285.				
Bending moment (Nm) Zero Score	350.				

TABLE 7—UPPER LEGFORM TO BUMPER TEST COMPARISON

	Consumer information programs				GTR 9 and UN R127 and KMVSS 102–2 and Japan article 18 att. 99
	Euro NCAP and ANCAP	JNCAP	KNCAP	C–NCAP	
Impact Velocity (kph)	40		40		40
Sum of forces (N) Max. Score	5000		5000		
Sum of forces (N) Zero Score	6000		7500		

[59] *https://unece.org/transport/standards/transport/vehicle-regulations-wp29/global-technical-regulations-gtrs.*

[60] The United Nations Economic Commission for Europe, Regulation No. 127–00, ''Motor Vehicles Pedestrian Safety Performance.''

TABLE 7—UPPER LEGFORM TO BUMPER TEST COMPARISON—Continued

	Consumer information programs				GTR 9 and UN R127 and KMVSS 102–2 and Japan article 18 att. 99
	Euro NCAP and ANCAP	JNCAP	KNCAP	C–NCAP	
Sum of forces (N) Limit					7500
Bending moment (Nm) Max. Score	285		300		
Bending moment (Nm) Zero Score	350		510		
Bending moment (Nm) Limit					510

TABLE 8—LOWER LEGFORM TO BUMPER TEST COMPARISON

	Consumer information programs				GTR 9 and UN R127 and KMVSS 102–2 and Japan article 18 att. 99
	Euro NCAP and ANCAP	JNCAP	KNCAP	C–NCAP	
Legform Used	Flex PLI	Flex PLI	Flex PLI	aPLI	Flex PLI.
Impact Velocity (kph)	40	40	40	40	40.
Ground clearance (mm)	75	75	75	25	75.
Femur bending (Nm) Max. Score				390.	
Femur bending (Nm) Zero Score				440.	
Tibia bending (Nm) Max. Score	282	202	282	275.	
Tibia bending (Nm) Zero Score	340	306	340	320.	
Tibia bending (Nm) Limit					340/380.
MCL elongation (mm) Max. Score	19	14.8	19	27.	
MCL elongation (mm) Zero Score	22	19.8	22	32.	
MCL elongation (mm) Limit					22.
ACL/PCL elongation (mm) Max. Score *	10	13	10.		
ACL/PCL elongation (mm) Zero Score *	10	13	10.		
ACL/PCL elongation (mm) Limit					13.

* In Euro NCAP, ANCAP, JNCAP, and KNCAP the ACL and PCL elongations act as modifiers. If the stated limit is exceeded that impact is awarded zero points regardless of the MCL or Tibia results.

The crashworthiness pedestrian protection test procedures in Euro NCAP consist of standardized instructions to (1) prepare a vehicle for testing, (2) conduct impact tests using various test devices, and (3) assess a vehicle's performance based on the result of the impact tests. Vehicles are first prepared by measuring and marking the front end of the vehicle in a prescriptive way to locate the test boundaries and impact points on the vehicle. The impact points are marked on a 100 mm by 100 mm grid on the hood, windshield, and surrounding components for the head impact tests; in a line along the hood (or bonnet) leading edge every 100 mm for the upper leg to WAD775 impact tests; and in a line along the front bumper every 100 mm for the lower leg to bumper impact tests. The Euro NCAP test procedures then provide instructions on how to prepare and launch the test devices at the predetermined impact points—specifically, the adult and child headforms for the hood and windshield area points, the TRL upper legform for the WAD775 points, and the FlexPLI for the bumper impact points. Finally, the procedures describe how a vehicle is scored and rated based on the resulting measurements collected from each impact test. The next several sections discuss in detail the individual tests and test procedures currently used in Euro NCAP and will be used in this proposed U.S. NCAP's crashworthiness pedestrian protection testing program.

1. Headforms and Head Impacts

As discussed earlier, since NHTSA began its research efforts on pedestrian safety in the 1980s and 1990s, head impact testing has been introduced in other NCAP programs (*e.g.,* Euro NCAP, ANCAP, JNCAP, KNCAP) worldwide. Test devices, specifically the child and adult headforms, have been standardized in other countries (*e.g.,* UNECE R127, Korean Motor Vehicle Safety Standard 102–2, Japan Article 18 Attachment 99, and Global Technical Regulation No. 9).

The headforms used in Euro NCAP are featureless, hemispherical impact devices that represent an adult and a 6-year-old child's head. Although each headform has the same diameter −165 mm (6.5 in), the adult headform weighs 4.5 kg (9.9 pounds), based on an average adult male, and the child headform weighs 3.5 kg (7.7 pounds). Early research and protocols used a smaller child headform with a mass of 2.5 kg (5.5 pounds) and a diameter of 130 mm and found the smaller and lighter headform produced higher accelerations when striking a hood but a heavier headform was more likely to bottom out against a hard underlying structure. Thus, mass was determined to be the most important parameter in assessing pedestrian head injury risk. The two head test devices cover a range of head masses from children to small adults to average sized adult males and encompasses a large percentage of adult females. The test procedures cover a range of components over an area of the vehicle that are injurious to pedestrians of all sizes. Both headforms use a triaxial arrangement of accelerometers to measure HIC values. The HIC skull fracture risk function is based on adult male cadaveric data but the Agency is not aware of biomechanical data suggesting that a female head may be more vulnerable than a male head for the same impact condition.[61] Therefore, NHTSA believes that any countermeasure that is beneficial for a male pedestrian would also be beneficial for a female pedestrian.

NHTSA proposes to use these headforms in the NCAP program proposed in this RFC. The adult headform that is used in Euro NCAP has been evaluated by NHTSA, and the Agency has published drawings and Procedures for Assembly, Disassembly,

[61] The head injury assessment reference values used for the 50th percentile adult male dummy and the 5th percentile adult female dummy are the same in frontal and side impact crash tests in NCAP and in Federal motor vehicle safety standards.

and Inspection (PADI).[62] Similarly, the Agency has evaluated the child headform and published drawings and the associated PADI.[63] Furthermore, both adult and child headforms from multiple manufacturers were evaluated for durability, repeatability, and reproducibility by conducting impact tests on a variety of U.S. fleet vehicles and found them to perform well.[64] Qualification procedures also exist for these test devices.[65]

Euro NCAP conducts head impacts at a speed of 40 kph (25 mph).[66] The tests are carried out over a large area on the front of the vehicle including the hood, windshield, and A-pillars on a 100 mm by 100 mm grid pattern. The child headform generally covers the portion of the vehicle's front end closer to the bumper, and the assessment zone for the adult headform covers an area further back, toward the windshield. The head impactors are aimed at the impact locations through the headform centerline and line of flight as shown in Figure 4. There is no HIC limit for each impact point, and Euro NCAP averages scores across all test locations—awarding higher scores for test locations with low HIC values (<650) and lower scores for test locations with high HIC values (≤1,700).

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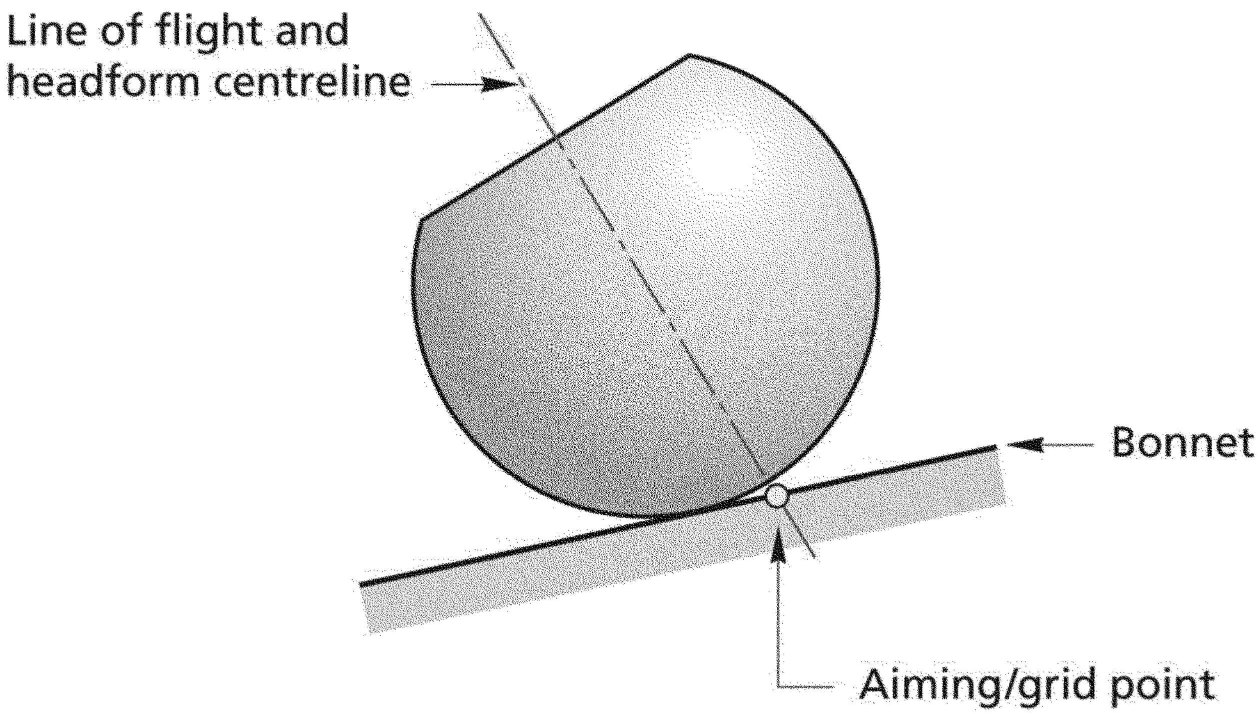

Figure 4: Head Impact Test Setup[67]

NHTSA has evaluated the Euro NCAP head impact test procedures over several years, including in support of NHTSA's 2015 RFC regarding potentially incorporating those test procedures into the U.S. NCAP. For that effort, NHTSA evaluated nine U.S. vehicles, including passenger cars, SUVs, pickups, and a minivan. The vehicles included both U.S. market-only and global platform vehicles. Since the latter vehicles are vehicles that are sold in the U.S. as well as in other countries, results from the Agency's tests could be compared to Euro NCAP scores. NHTSA's assessment of the global platform vehicles showed that not only the head impact location markups but also the resulting headform scores were similar.

2. Legforms and Leg Impacts

In addition to the headforms mentioned above, Euro NCAP also currently uses a pair of legforms for crashworthiness pedestrian protection safety evaluations. One of these legforms is a test device used in Euro NCAP to evaluate injuries to the upper leg, pelvis, and hip. This upper legform impactor, created by the Transport Research Laboratory (TRL), measures bending moments for femur fracture and forces for pelvis fracture. The TRL upper legform impactor consists of a front and rear member with a torque limiting joint, which is used to protect the test equipment in cases of extreme forces. The device is wrapped in two layers of foam to simulate a human leg with flesh. The TRL upper legform also has adjustable ballast to change the impactor mass depending on the test application. A comprehensive NHTSA evaluation, which was published in

[62] Both documents are available at: *https://www.regulations.gov/document/NHTSA-2019-0112-0024.*

[63] Both documents are available at: *https://www.regulations.gov/document/NHTSA-2019-0112-0025.*

[64] Suntay, B., Stammen, J., Vehicle Hood Testing to Evaluate Pedestrian Headform Reproducibility, GTR No. 9 Test Procedural Issues, and U.S. Fleet Performance, August 2018.

[65] *https://www.regulations.gov/document/NHTSA-2019-0112-0028.*

[66] See Euro NCAP Pedestrian Testing Protocol V8.5 Section 12 ''Headform Testing'' for instructions for carrying out the headform impact tests. euro-ncap-pedestrian-testing-protocol-v85.201811091256001913.pdf (euroncap.com).

[67] Copyright Euro NCAP 2018. Reproduced with permission from Euro NCAP Pedestrian Testing Protocol V8.5 Figure 24.

2019, found that the TRL upper legform impactor was durable, repeatable, reproducible, sensitive to vehicle design, and could measure the relative stiffness of a vehicle's leading edge.[68] Similar to the other test devices discussed in this notice, NHTSA has published drawings and a PADI for the TRL upper legform impactor.[69]

The TRL upper legform impactor is utilized in two separate tests.[70] In Euro NCAP, the upper legform may be used in place of the FlexPLI legform for bumper impacts on certain vehicles. If the lower bumper reference line (LBRL), as measured in Figure 5,[71] is equal to or greater than 425 mm but less than or equal to 500 mm, the vehicle manufacturer may choose to use either the FlexPLI or the TRL upper legform for bumper impact tests. [72] [73] If the LBRL of a vehicle is greater than 500 mm, the TRL upper legform impactor must be utilized on those vehicles. The FlexPLI is not utilized in vehicles with very high LBRL (greater than 500 mm) due to the impactor's poor kinematic response.

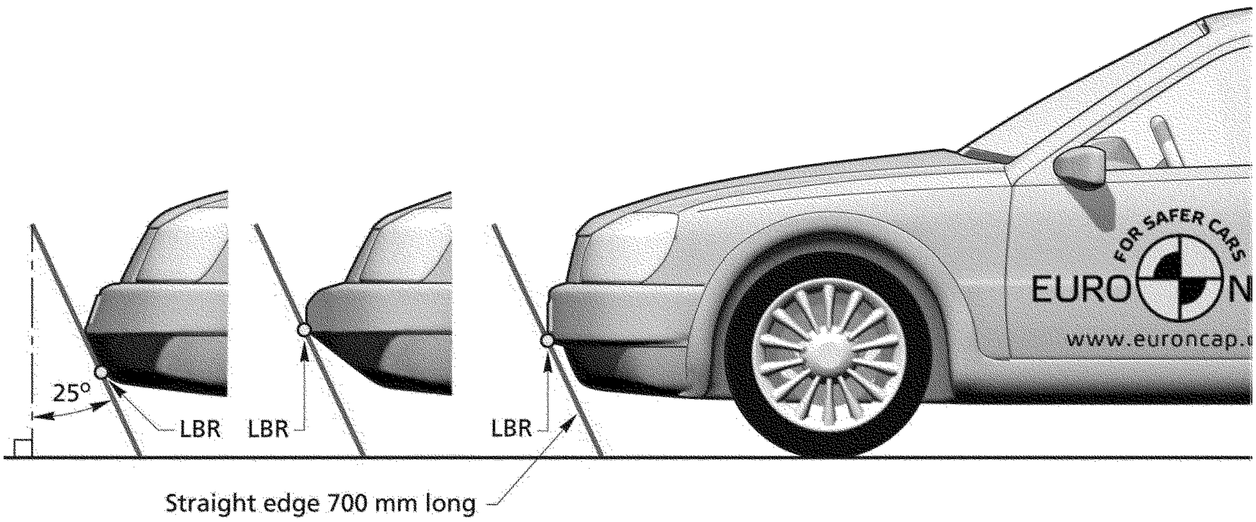

Figure 5: Marking the Lower Bumper Reference Line (LBRL)[74]

Additionally, Euro NCAP employs an impact test along the bonnet (or hood) leading edge with the TRL upper legform impactor known as the Upper Legform to WAD775mm Test.[75] The WAD775 test, which is conducted at a WAD of 775 mm, simulates a pedestrian's upper leg and hip wrapping around the front end of the vehicle in the transition area between the bumper and the hood. Because the pedestrian's hip wraps around the front end of the vehicle, the upper legform impactor is set up to strike the vehicle at an angle perpendicular to the internal bumper reference line (IBRL) (shown in Figure 6) and a point along the WAD at 930 mm.[76] These tests are conducted at a speed between 20 and 33 kph (12 and 21 mph) and at an impact angle depending on vehicle geometry, and maximum points are awarded for forces below 5 kN and bending moments below 280 Nm. The test setup is shown in Figure 7. Vehicles with higher front ends tend to have lower impact angles (relative to horizontal) and higher impact speeds with more energy. Vehicles with lower front ends tend to have higher impact angles (relative to horizontal) and lower impact speeds with less energy. The Upper Legform to WAD775mm Test in Euro NCAP has remained the same since 2015.

[68] *https://www.regulations.gov/document/NHTSA-2019-0112-0007.*

[69] *https://www.regulations.gov/document/NHTSA-2019-0112-0027.*

[70] Unlike the headform and FlexPLI impactor tests, which are projectile impacts, the TRL upper legform impactor test is a linearly guided impact.

[71] The LBRL is identified by the geometric trace between the bumper and a straight edge at a 25° forward incline. It represents the lower boundary of significant points of contact with a pedestrian leg and the bumper.

[72] Euro NCAP plans to remove this option beginning with MY 2023, see Vulnerable Road User Testing Protocol V9.0 at *https://www.euroncap.com/en/for-engineers/protocols/vulnerable-road-user-vru-protection/.*

[73] See Euro NCAP Pedestrian Testing Protocol V8.5 Section 9 ''Legform Tests'' for instructions for carrying out the FlexPLI to bumper impact test and Section 10 ''Upper Legform to Bumper Tests'' for instructions for carrying out the upper legform to bumper impact test. euro-ncap-pedestrian-testing-protocol-v85.201811091256001913.pdf (euroncap.com).

[74] Copyright Euro NCAP 2018. Reproduced with permission from Euro NCAP Pedestrian Testing Protocol V8.5 Figure 13.

[75] See Euro NCAP Pedestrian Testing Protocol V8.5 Section 11 ''Upper Legform to WAD775mm Tests'' for instructions for carrying out the upper legform to WAD775 test. euro-ncap-pedestrian-testing-protocol-v85.201811091256001913.pdf (euroncap.com).

[76] The IBRL height is identified where a vertical plane contacts the bumper beam up to 10mm into the profile of the bumper beam.

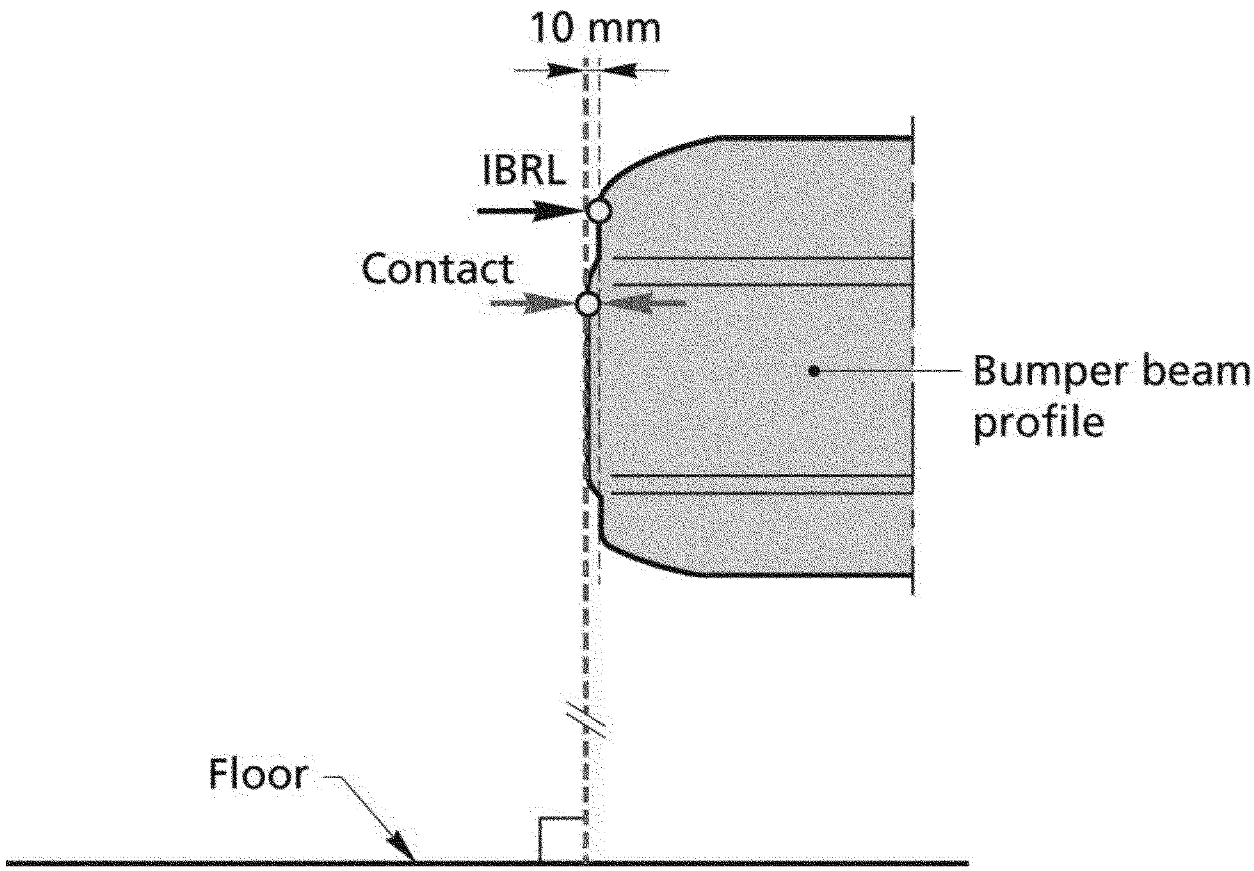

Figure 6: Internal Bumper Reference Line (IBRL)[77]

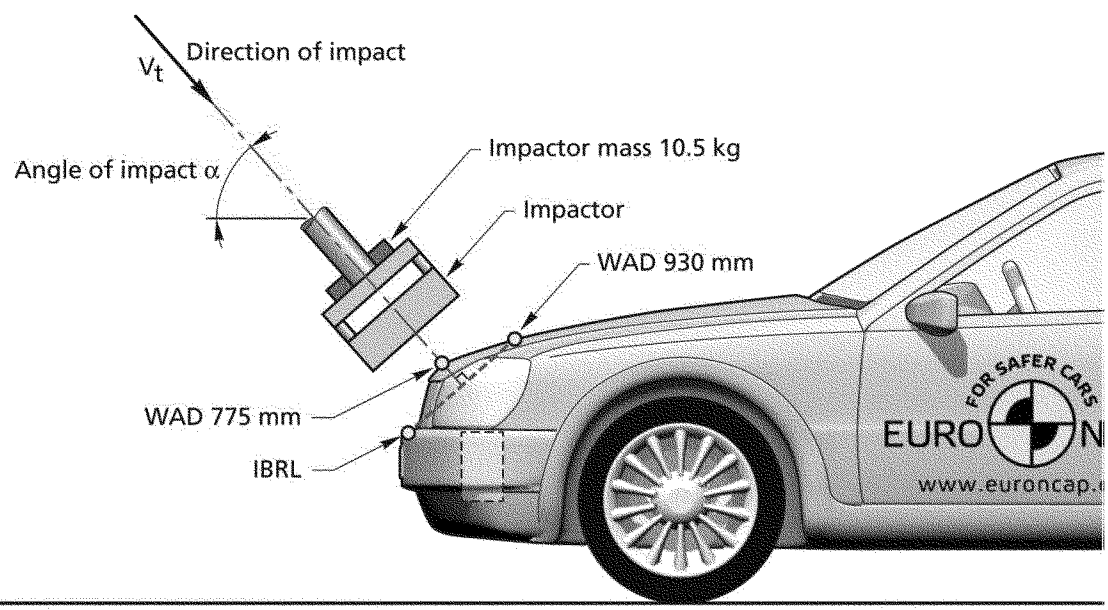

Figure 7: Upper Legform to WAD775 Test Setup[78]

In addition to the TRL upper legform, the Flexible Pedestrian Legform Impactor (FlexPLI), represents an adult human's femur, knee, and tibia. Prior to the creation of the FlexPLI, the European Enhanced Vehicle-Safety Committee (EEVC) legform impactor was utilized in Euro NCAP. The EEVC legform had limitations because (1) it has a rigid femur and tibia, (2) the knee joint was unable to simulate combined loading, and (3) the steel ligaments needed to be replaced after every test. Unlike the EEVC legform impactor, the FlexPLI has not only an articulated femur and leg bone elements but also an articulated knee structure. The bone elements for the FlexPLI are instrumented with strain gauges, and the knee segment is instrumented with four potentiometer ligaments that retract and elongate. The entire FlexPLI assembly, which weighs 13.2 kg (29.1 pounds), is wrapped in rubber layers and a neoprene cover simulating flesh and skin of a human leg. The FlexPLI has been used by Euro NCAP since 2014. In 2014, a comprehensive NHTSA evaluation of the FlexPLI found the impactor to be durable, biofidelic, repeatable, reproducible, and sensitive to vehicle design.[79] NHTSA has published drawings and a PADI for the FlexPLI.[80]

To evaluate injuries to a pedestrian's knee and lower leg, the FlexPLI is launched in free flight, perpendicular to the ground, at a fixed height, into the front bumper of a vehicle at an impact velocity of 40 kph (25 mph).[81] The test setup is shown in Figure 8. The FlexPLI test has remained relatively the same in Euro NCAP since its addition to the program in 2014. Euro NCAP evaluates tibia bending moments and knee ligament elongations. Maximum points are awarded for tibia bending moments 282 Nm and lower, and zero points are awarded for tibia bending moments above 340 Nm. Knee ligament elongations are measured for the medial collateral ligament (MCL), and maximum points are awarded for an elongation less than 19 mm and zero points are awarded for an elongation greater than 22 mm. In addition, the anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) cannot exceed 10 mm elongation.

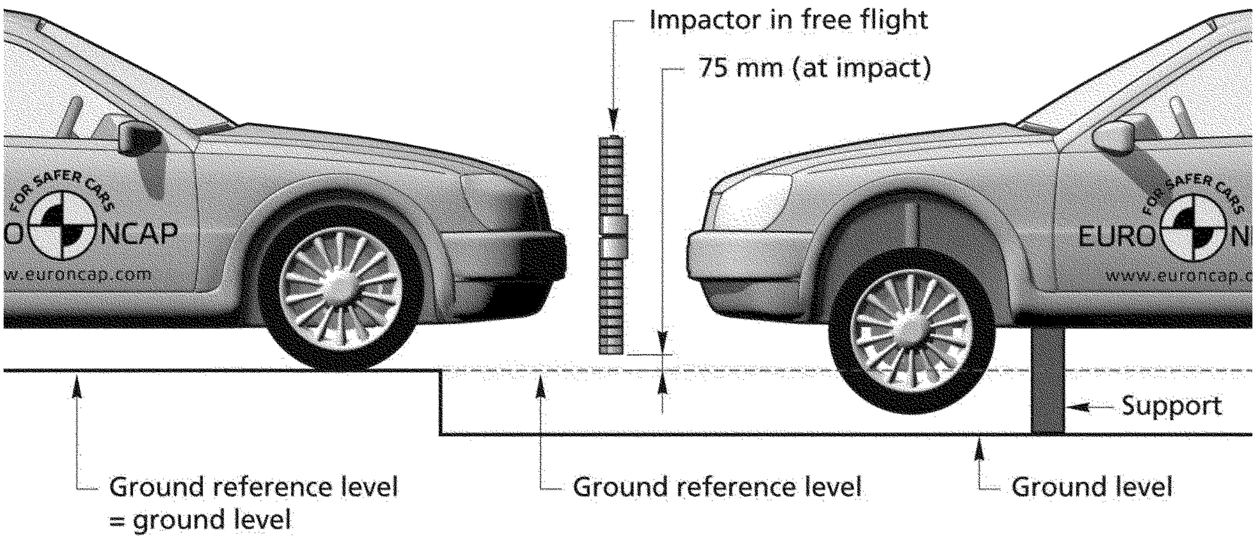

Figure 8: FlexPLI to Bumper Test Setup[82]

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The upper legform and the FlexPLI are based on a 50th percentile average adult male in both mass and stature. These legforms are the most current anthropomorphic legforms available that have been thoroughly researched and reviewed by NHTSA. Comments are requested on whether other legforms that represent smaller adult females are available, the injury criteria and test procedures associated with them, and the safety need for such legforms. As with the headforms, NHTSA believes that testing with heavier legforms is more stringent because the heavier legforms are more likely to bottom out on and hit more rigid structures. NHTSA seeks comment on the topic of female leg safety. Are there data showing that vehicle front end designs that perform well in the FlexPLI and upper legform impact tests would not afford protection to female pedestrians? Are there any legforms representing female or small stature pedestrians? Are there female specific data and associated 5th percentile female specific injury criteria for use with a 5th percentile female legform impactor? [1] [83]

E. Response to Comments Received in Previous Actions

The following section addresses comments received from the public in response to NHTSA's December 2015 RFC section on pedestrian protection and the public meeting in 2018.

[77] Copyright Euro NCAP 2018. Reproduced with permission from Euro NCAP Pedestrian Testing Protocol V8.5 Figure 15.

[78] Copyright Euro NCAP 2018. Reproduced with permission from Euro NCAP Pedestrian Testing Protocol V8.5 Figure 29.

[79] *https://www.regulations.gov/document/NHTSA-2019-0112-0003.*

[80] *https://www.regulations.gov/document/NHTSA-2019-0112-0026.*

[81] See Euro NCAP Pedestrian Testing Protocol V8.5 Section 9 ''Legform Tests'' for instructions for carrying out the FlexPLI to bumper impact test.

[82] Copyright Euro NCAP 2018. Reproduced with permission from Euro NCAP Pedestrian Testing Protocol V8.5 Figure 26.

[83] The number in square brackets signifies the question number on which NHTSA seeks comment.

1. General Pedestrian Protection Comments

NHTSA received many comments in general support of adding a crashworthiness pedestrian protection testing component to NCAP. Furthermore, many of the comments in response to the December 2015 notice stated that both pedestrian crash avoidance and pedestrian crashworthiness elements were appropriate for inclusion in NCAP. The Agency's most recent RFC, which was issued in March 2022, proposed to include pedestrian automatic emergency breaking technology in NCAP. That proposal focused on the crash avoidance aspect of pedestrian safety in NCAP. The March 2022 notice also included a roadmap outlining crashworthiness pedestrian protection as a future update. NHTSA received a number of comments in support of adding crashworthiness pedestrian protection to NCAP, with commenters noting that vehicles are getting larger and pedestrian and cyclist fatalities are increasing in recent years. The commenters requested adopting a crashworthiness pedestrian protection testing program and rating system similar to that implemented in Euro NCAP. Commenters requested ensuring protection for a wide range of pedestrian sizes and weights. Some suggested designing the tests to protect children and smaller adults and others suggested including protection for cyclists and using female specific test devices. This proposal continues the Agency's efforts to improve pedestrian safety from a crashworthiness perspective, demonstrating a multi-prong approach to improving pedestrian safety and preventing pedestrian injury and death related to motor vehicle crashes in the United States.

A common theme in the comments received from the public on NCAP updates was that NHTSA should work to harmonize with other NCAPs; thus, many commenters were supportive of the proposal in the December 2015 Notice to adopt the Euro NCAP test procedures. However, a few commenters noted that harmonization may not always be appropriate because (1) there are differences in the U.S. and European vehicle fleet and (2) different tests may address a broader spectrum of real-world scenarios. Many commenters also suggested that NHTSA continue to monitor updates to Euro NCAP and consider applying those to the U.S. NCAP.

The proposal in this RFC draws from the most recent Euro NCAP pedestrian crashworthiness test procedures.[84] Although NHTSA is mainly proposing to adopt the Euro NCAP test devices and test procedures, to ensure that the overall score better reflects the pedestrian protection provided by the vehicle's front end, the Agency is proposing some changes to FlexPLI and TRL upper legform bumper and WAD775 testing. As noted by many commenters in the March 2022 notice, U.S. vehicle front ends are getting taller and these changes to the test procedure will ensure these taller vehicles are tested appropriately. Furthermore, NHTSA is proposing changes to the apportionment that each test device contributes to a vehicle's overall score, to align with injury data in the U.S.

A few commenters specifically requested that NHTSA use the Euro NCAP pedestrian crashworthiness test procedures rather than the GTR 9 procedures for the U.S. NCAP because the grid markup method and point scoring method have been shown to be suitable for use to evaluate and score vehicles in that consumer information program. NHTSA is considering Euro NCAP test procedures for inclusion in the U.S. NCAP in this proposal.

Some commenters, including the Alliance for Automotive Innovation (formerly the Alliance of Automobile Manufacturers and Association of Global Automakers), suggested that pedestrian crashworthiness was not appropriate for NCAP, but would instead be more appropriate for a Federal motor vehicle safety standard (FMVSS). The Agency agreed to portions of GTR 9 and is currently developing a rulemaking proposal on requirements to protect pedestrian heads impacting vehicle hoods that is based on the requirements in GTR 9.[85] On first impression these programs might appear identical, but there are important differences that differentiate the NCAP proposal discussed in this RFC from the future GTR 9 rulemaking that the Agency is developing. The proposal in this RFC evaluates protection afforded by the front of vehicles for the head, pelvis, leg, and knee in pedestrian impacts with the front of the vehicle, while the GTR 9 rulemaking focuses on protection for the head. There are also key differences for the head impact testing procedures. Those differences between GTR 9 and Euro NCAP (which are similar to that proposed in this RFC) are detailed in Tables 4 and 5. Specifically, the headform impact speed in this RFC is 5 km/h greater than that in GTR 9. Additionally, the Agency proposes to conduct impact tests on the windshield with the adult headform if the windshield is within WAD of 2100 mm while GTR 9 does not conduct head impact tests beyond the hood test area. This proposal to include a crashworthiness pedestrian protection testing program in NCAP along with a future rulemaking proposal (GTR 9) align with previous agency efforts to address a safety need using both non-regulatory and regulatory approaches. One example would be the incorporation of a dynamic pole test in Federal motor vehicle safety standard (FMVSS), No. 214, ''Side impact protection,'' [86] as well as NCAP.[87] In addition, BIL explicitly incorporates concern over the safety of pedestrians and other vulnerable road users into NCAP, thus making any question that may have existed on this issue at the time of the 2015 notice moot.

In its comment, BMW questioned the effectiveness of a crashworthiness pedestrian protection testing program. BMW noted that pedestrian crashworthiness requirements are part of European and Japanese regulations, and it is unclear if the reductions in pedestrian injuries and fatalities in Europe and Japan are due to these regulations or due to improvements in roadway infrastructure. As noted earlier, a review of 7,576 crashes in the German National Accident Records from 2009–2011 involving Euro NCAP rated vehicles showed a significant correlation between Euro NCAP pedestrian score and injury outcome in real-life car-to-pedestrian crashes.[88] Comparing a vehicle that earned 5 points to a vehicle that earned 22 points, the conditional probability of fatal injury to a pedestrian from the latter vehicle was reduced by 35 percent. Additionally, the probability of serious injury from the latter vehicle was reduced by 16 percent.[89] Furthermore, a review of the FlexPLI bumper tests from the Federal Highway Research Institute (BASt) indicated that 11 fatalities and 506 serious injuries

[84] Euro NCAP Pedestrian Testing Protocol—euro-ncap-pedestrian-testing-protocol-v85.201811091256001913.pdf (euroncap.com) and Part I Pedestrian Impact Assessment in *https://cdn.euroncap.com/media/67553/euro-ncap-assessment-protocol-vru-v1005.pdf.*

[85] RIN AK98 on the 2022 Spring Agenda available at *https://www.reginfo.gov/public/do/eAgendaMain.*

[86] 72 FR 51908.

[87] 73 FR 40015.

[88] Pastor C. Correlation between pedestrian injury severity in real-life crashes and Euro NCAP pedestrian test results, In: Proceedings of the 23rd Technical Conference on the Enhanced Safety of Vehicles (ESV). Seoul, 2013.

[89] See Table 21 in appendix A.

were reduced annually[90] in Germany.[91] BASt conducted this study in relation to the GTR 9 testing requirements (not Euro NCAP requirements). However, the test procedures are similar (same impactor and similar test speed) to those in Euro NCAP, but the Euro NCAP testing protocol has more stringent injury criteria to achieve a non-zero score.

Some commenters to the March 2022 NCAP RFC requested a rating system for crashworthiness pedestrian protection similar to EuroNCAP. Several previously received comments suggested a ''soft landing'' approach to introducing new elements in NCAP. A soft landing is an approach in which requirements are either gradually introduced or the stringency is gradually increased. The Agency agrees that there is merit to such an approach and therefore is introducing the crashworthiness pedestrian protection testing program in NCAP first as a program similar to the current crash avoidance testing program in NCAP. In other words, NHTSA would give credit to vehicles that pass the Agency's performance test criteria on the Agency's website. Initially, it will not be part of a rating system. As discussed in the March 2022 notice, after NHTSA completes its comprehensive consumer research on updating the safety rating section of the Monroney label, the Agency plans to completely overhaul its ratings system to include, among other things, crash avoidance testing, crashworthiness pedestrian testing, and other planned updates. By introducing the crashworthiness pedestrian testing program in this manner, NHTSA intends to encourage early adopters by highlighting vehicles that perform well, while also providing sufficient time for manufacturers to plan and incorporate the necessary design changes for pedestrian safety improvements before the label includes information about new crash avoidance or pedestrian protection systems.

Many individuals who support initiatives from the League of American Bicyclists suggested that NHTSA should incorporate bicyclists into the Agency's assessment of pedestrian safety. NHTSA notes that, at this time, there are not widely accepted objective test procedures for crashworthiness bicyclist protection evaluation of vehicles, and thus it does not meet the four prerequisites for inclusion NCAP. However, it may be possible that countermeasures that reduce injury risk for pedestrians may also have a positive effect for bicyclists. The Agency recognizes that Euro NCAP has proposed incorporating bicyclist impact tests in the future. NHTSA will continue to monitor that effort, continue to evaluate whether objective test procedures can be developed, and may reassess the inclusion of bicyclist safety in NCAP in the future.

2. Part 581 Issues

Many vehicle manufacturers noted that NHTSA's proposal to incorporate Euro NCAP lower leg bumper testing as part of the proposed pedestrian crashworthiness testing program would be difficult due to conflicts with the bumper damageability requirements outlined in 49 CFR part 581. Commenters argued that part 581 bumper damageability requirements require designs to a vehicle's front end that tend to increase the severity of injury to pedestrians. Commenters also noted that the United Nations Economic Commission for Europe Regulation No. 42 (ECE R42) bumper standard allows more flexibility in vehicle front end design and requested that NHTSA consider replacing the part 581 bumper standard with a standard similar to ECE R42.

NHTSA has examined potential conflicts between the part 581 requirements and pedestrian crashworthiness leg impact testing. During the 2014 Society of Automotive Engineers Government/Industry Meeting, NHTSA presented the results of its research study.[92] One of the vehicles tested for this study was the 2013 Ford Fusion, which is subject to part 581 bumper requirements. The Ford Fusion passed all GTR 9 lower leg injury requirements without modification.[93] Similarly, a 2011 Chevrolet Cruze and a 2006 Volkswagen Passat were also included in this study. These two vehicles were U.S. vehicles subject to part 581 bumper requirements that were modified with parts from their corresponding overseas models. In both cases, the lower apron was replaced with the comparable overseas part, which was believed to be stiffer than the U.S. part. Once modified, the Chevrolet Cruze met the GTR 9 lower leg injury requirements and the Volkswagen Passat nearly met the lower leg injury requirements. At the conclusion of the GTR 9 testing, these three vehicles were evaluated to see if they met the part 581 impact requirements.[94] Although the part 581 testing was not exhaustive and only the frontal pendulum test was conducted, all vehicles passed without incident. Furthermore, although these vehicles were evaluated using the GTR 9 FlexPLI test procedures and injury criteria, the Euro NCAP FlexPLI test procedures and injury criteria are very similar, and it is therefore anticipated that vehicles will be able to meet both part 581 requirements and receive a non-zero score in the Euro NCAP FlexPLI tests.

More recently, NHTSA conducted fleet testing on several U.S. vehicles using the Euro NCAP test procedures.[95] Among these vehicles were global platform vehicles that were believed to be equipped with some pedestrian safety countermeasures. One of these models, a 2016 Toyota Prius, obtained a good result of 4.41 out of 6.00 points for the lower leg impact testing. The 2016 Prius was also subject to part 581. Although other global platform vehicles that were also subject to part 581 did not perform as well, the case of the Toyota Prius shows that it is possible to meet both lower leg impact tests and part 581 requirements.

3. Test Device Issues

Some commenters requested that pedestrian crashworthiness test devices be federalized into 49 CFR part 572 before including them in NCAP. NHTSA does not plan to incorporate the test devices into part 572 at this time, but has instead released drawings, PADIs, and qualification procedures to inform stakeholders that NHTSA will be using those test device specifications and procedures as well as the criteria set forth in this RFC to award credit to vehicles that meet the Agency's performance testing criteria.

A variety of commenters raised issues with the various test devices proposed for pedestrian crashworthiness testing. Many of these comments raised concerns with the FlexPLI related to the qualification procedures, biofidelity, and usage in bumper testing. When the FlexPLI was proposed in the 2015 RFC, the test device was relatively new (compared to the more mature headforms), and Euro NCAP had used it for about one year. Since the Agency's 2015 proposal, there have been no changes to the FlexPLI, and it has been

[90] This study utilized ''AIS–1'' shifting where some fatalities would have instead been serious injuries and where some serious injuries would have instead been slight injuries.

[91] Estimation of Cost Reduction due to Introduction of FlexPLI within GTR9. 5th Meeting of Informal Group GTR9 Phase 2. Federal Highway Research Institute (BASt). Bergisch Gladbach, December 6th—7th, 2012. Available at *https://wiki.unece.org/display/trans/GTR9-2+5th+session.*

[92] *https://www.regulations.gov/document/NHTSA-2019-0112-0023.*

[93] See Table 22 in appendix A.

[94] See Table 23 in appendix A.

[95] DOT HS 812 723.

adopted by other programs including phase 2 of GTR 9.

Commenters also questioned the biofidelity of the TRL upper legform impactor. While NHTSA agrees there is limited biomechanical basis for upper leg measurements, the Agency's research has shown that, as a test tool, the upper legform impactor demonstrates the ability to measure the relative stiffness of a vehicle's front end and is sensitive to different vehicle designs. Therefore, the Agency believes it is an acceptable tool to evaluate the pedestrian crashworthiness of a vehicle's front end. Also, several commenters questioned the repeatability and reproducibility of the TRL upper legform impactor. NHTSA investigated the repeatability and reproducibility of the upper legform in both qualification testing and vehicle testing.[96] For the repeatability tests, which used the same impactor to strike a vehicle multiple times in the same location, all tests were conducted with a coefficient of variation (CV) less than 10 percent. CV is a measure of variability expressed as a percentage of the mean, and a CV of less than 10 percent is considered acceptable.[97] Similarly, the reproducibility tests, which used multiple legforms to impact the same location, produced a CV less than 10 percent in 21 of the 24 impacts. During this testing, NHTSA found that the foams used in the upper legform are sensitive to changes in temperature and humidity. Therefore, NHTSA is considering qualification and vehicle test humidity ranges more tightly defined than that specified in the standards currently used in other countries. NHTSA seeks comment on what an acceptable humidity tolerance should be for the qualification tests of the upper legform impactor and the associated vehicle test with the upper legform. [2]

With regard to the FlexPLI, Humanetics suggested that NHTSA incorporate the qualification tests from UNECE R127. UNECE R127 specifies two dynamic qualification tests—a Pendulum test and an Inverse Impact test, in addition to a series of quasi-static tests. In UNECE R127, the dynamic qualification tests are performed before and throughout a test series, while the quasi-static tests are performed on an annual basis. Euro NCAP only specifies the dynamic Inverse Impact test and the quasi-static tests. NHTSA conducted its evaluation of the FlexPLI using only the Pendulum qualification test and did not evaluate the Inverse Impact test. The Agency found the Pendulum test to be efficient, repeatable, and easy to conduct without disturbing the vehicle setup. NHTSA did not evaluate the quasi-static deflection qualification tests. However, NHTSA is in the process of evaluating the Inverse Impact qualification test. NHTSA is requesting comment on the FlexPLI qualification procedures—specifically which procedures (dynamic and quasi-static) should be used for qualification, and how often they should be conducted? [3]

Some commenters expressed concern with using the FlexPLI to test vehicles that have higher bumpers such as large trucks and SUVs. In Euro NCAP and GTR 9, the TRL upper legform can be used in lieu of the FlexPLI for vehicles with an LBRL equal to or greater than 425 mm but less than or equal to 500 mm. NHTSA does not believe this is appropriate for a consumer information program and instead proposes the use of the FlexPLI for any vehicle with an LBRL less than or equal to 500 mm. For vehicle models with an LBRL between 425 mm and 500 mm, where the TRL upper legform was used instead of the FlexPLI (as permitted in Euro NCAP), it could lead to a better score as discussed in a later section of this notice, giving consumers a false impression of the vehicles' crashworthiness pedestrian protection performance.

Ford commented that the apportionment of the leg impacts to the overall pedestrian score should remain low until technical challenges are addressed with the legforms. While NHTSA believes that there are no remaining technical issues preventing the use of the FlexPLI and upper legform in pedestrian impact tests, the Agency is seeking comment on the combined scoring of the head impact, lower leg impact, and upper leg impact tests. In Euro NCAP, head impact tests account for 24.00 out of the maximum 36.00 points (67 percent). Each leg impact test accounts for 6.00 of the remaining 12.00 points.[98] In a NHTSA study that evaluated the relative frequency of injuries in the U.S., the Agency found that the proportion of pedestrian injury across body regions did not align with the Euro NCAP proportion of points awarded.[99] An Agency study of Abbreviated Injury Scale (AIS) [100] 3+ pedestrian injuries in the U.S. showed that the apportionment of points in NCAP for crashworthiness pedestrian protection should be 3/8th for head impact test results (37.5 percent), 3/8th for lower leg impact test results (37.5 percent), and 2/8th for upper leg impact test (25 percent).[101] NHTSA seeks comment on whether injury severity or frequency would be the most appropriate basis for point allocation apportionment. [4]

The Partnership for Dummy Technology and Biomechanics (PDB) commented on biofidelity concerns related to the FlexPLI legform, specifically regarding the knee and ligaments. As concluded in the Agency's FlexPLI research report, NHTSA believes the FlexPLI legform is biofidelic and seeks comment from the public on whether biofidelity concerns with the FlexPLI still remain at this time. [5]

Many commenters discussed the impact angle of the FlexPLI relative to the front bumper. In Euro NCAP, the FlexPLI is launched parallel to the travel direction of the vehicle. Commenters noted that tests on the outside edges of the test zone may have a large impact angle due to the curvature of the bumper and lead to excessive rotation in the FlexPLI, reduce biofidelity of the test device, and cause erroneous ligament measurements. Some commenters suggested that all lower leg impacts should be performed normal (*i.e.,* perpendicular) to the point of contact on the bumper. NHTSA does not agree that all lower leg impacts should be performed normal to the point of contact because that would make the tests less comparable to real-world conditions. Additionally, performing tests normal to each impact point would increase test complexity because the vehicle or the launcher would need to be moved in an arc instead of along a single axis. However, the Agency notes that defining the corners and test width of a vehicle is an area where the regulations (GTR 9 and UNECE R127) differ from Euro NCAP. Since the corners of bumpers are often swept back, these areas can lead to more oblique impact points. Euro NCAP uses a vertical plane at a 60-degree angle to

[96] *https://www.regulations.gov/document/NHTSA-2019-0112-0007.*

[97] Rhule, D., Rhule, H., & Donnelly, B. (2005). The process of evaluation and documentation of crash test dummies for part 572 of the Code of Federal Regulations. 19th International Technical Conference on the Enhanced Safety of Vehicles, Washington, DC, June 6–9, 2005.

[98] For 2023 and beyond, Euro NCAP has noted that head testing will contribute 18/36 points and the leg tests will contribute the other 18/36 points.

[99] *https://www.regulations.gov/document/NHTSA-2019-0112-0006.*

[100] The Abbreviated Injury Scale is a 6-point ranking system used for ranking the severity of injuries. AIS 3+ Injuries means injuries of severity level 3 (serious), 4 (severe), 5 (critical), and 6 (fatal) according to the Abbreviate Injury Scale. *www.aaam.org.*

[101] See Table 24 in appendix A.

mark the bumper corner (shown in Figure 9), compares this width to that of the hard bumper beam, and tests the larger of the two areas. The regulations instead use a corner gauge method at a 60-degree angle that can be moved vertically, which generally decreases the bumper test zone width but is intended to alleviate extreme impact angles—as illustrated in Figure 10 and Figure 11. Section IV.F.1.f of this notice discusses in detail the corner gauge method. In NHTSA's fleet testing with the FlexPLI using the Euro NCAP test procedures, the Agency did not encounter issues with impact points along the corners. Also, the Agency evaluated the FlexPLI for GTR 9, but that study was performed before the updates made in the regulations to use the corner gauge method. NHTSA is seeking comment on what procedure it should use for marking the test zone on bumpers. In other words, should the procedure harmonize with the Euro NCAP 60-degree angle method or should it follow the GTR 9 and UNECE R127 corner gauge method? [6]

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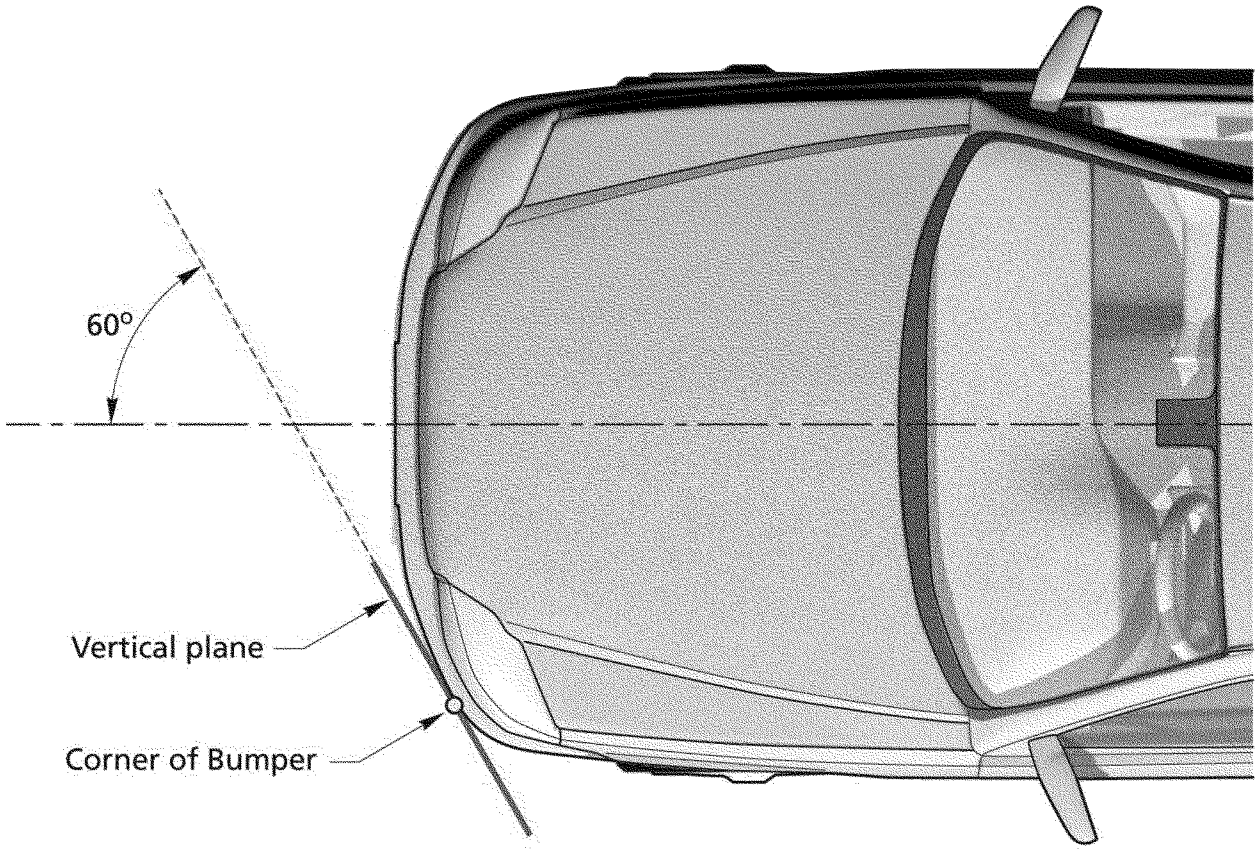

Figure 9: Determination of the Bumper Corner in Euro NCAP[102]

[102] Copyright Euro NCAP 2018. Reproduced with permission from Euro NCAP Pedestrian Testing Protocol V8.5 Figure 14.

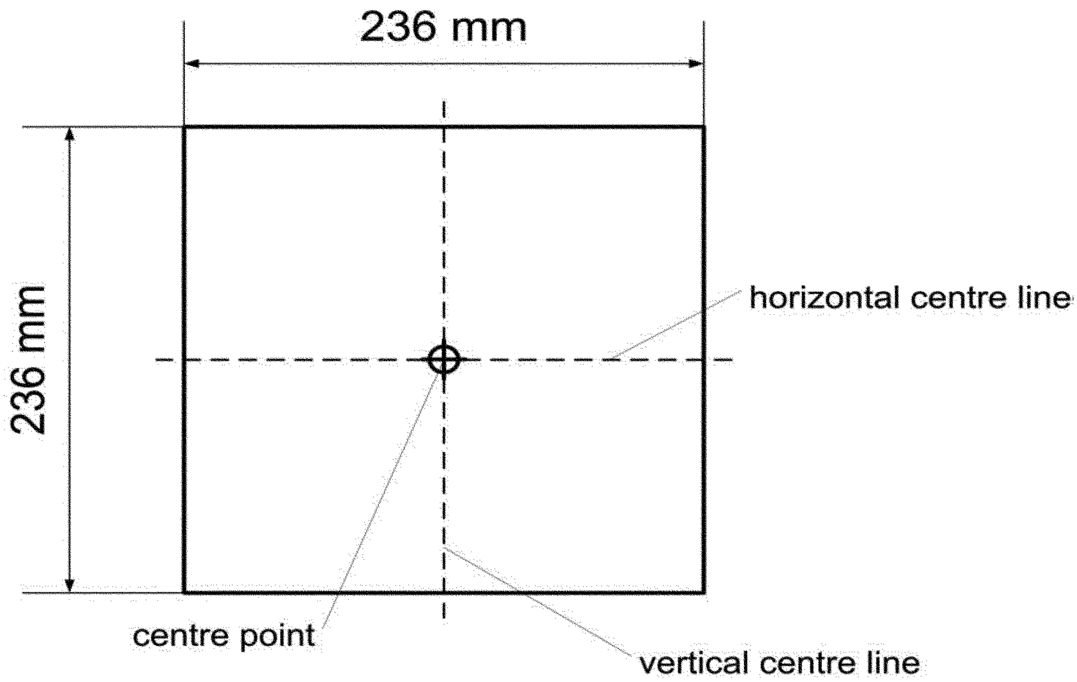

Figure 10: Bumper Corner Gauge[103]

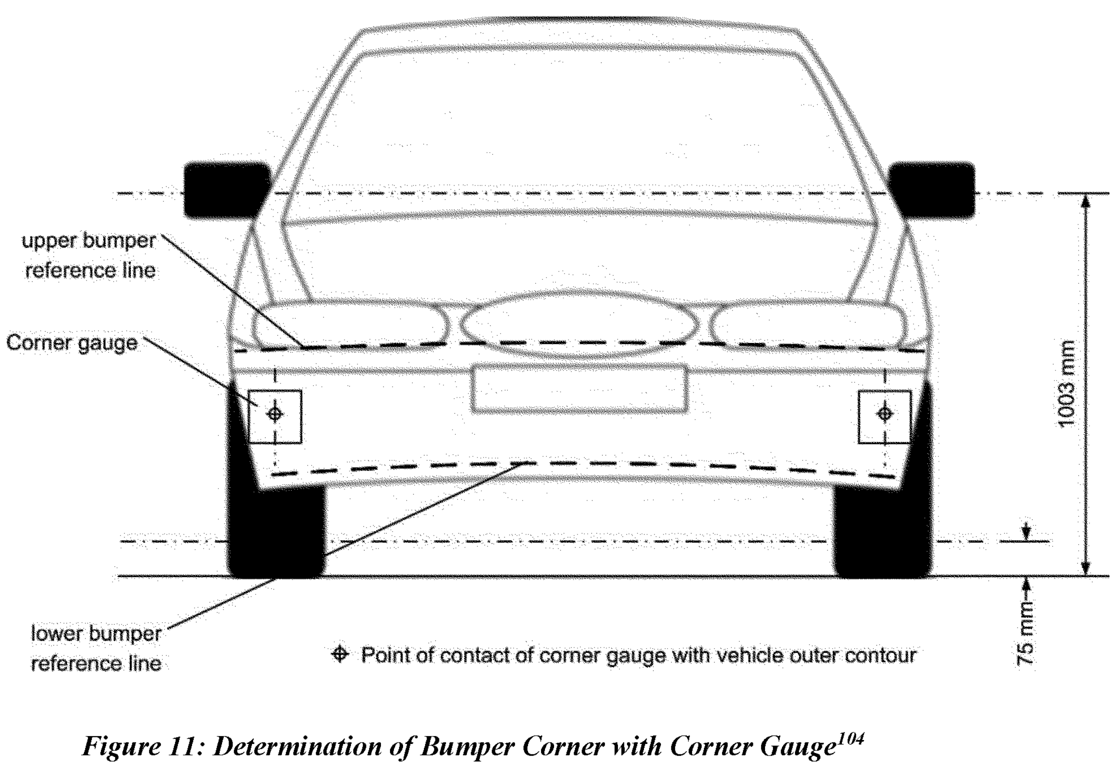

Figure 11: Determination of Bumper Corner with Corner Gauge[104]

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Similar to the above concerns with FlexPLI impacts at high angles, GM commented that trucks and other large vehicles with exposed metal bumpers warrant additional consideration. GM suggested that if a vehicle has an exposed bumper, the bumper test zone should use the 60-degree angle method instead of testing the full bumper width to eliminate testing at the extreme edge of what may be a curved bumper. NHTSA requests comment on this concern as well, as it is similar to the previous question for bumper test zones. [7]

Some commenters to the March 2022 RFC requested that NHTSA utilize female specific test devices for crashworthiness pedestrian protection testing and ensure protection for a wide range of pedestrian sizes and weights, including children and small adults. NHTSA discussed the headform and legform test devices and test procedures in Section IV.D. of this notice and noted that we believe protection will be afforded to a range of pedestrian sizes from children to large adults because of the large test zone and variety of components that are evaluated in these tests. Furthermore, we noted that we are not aware of female specific leg test devices available for evaluation at this time, but request comment on the issue.

F. Proposal in Detail

In the December 2015 RFC, NHTSA proposed adopting Euro NCAP test devices, test procedures, and scoring methods for its crashworthiness pedestrian protection testing program in NCAP. As stated in the 2015 notice, the Euro NCAP test procedures and test devices simulate a 6-year-old child and average-size adult male crossing the street and being struck in the side by a vehicle travelling at 40 kph (25 mph). NHTSA notes that the twenty-five miles per hour test speed reflects real-world pedestrian head to hood impacts. As impact speed increases so does the likelihood that a pedestrian's head overshoots the vehicle's hood and windshield, especially in vehicles with lower front ends. However, given the pedestrian death and injury crisis on U.S. roadways NHTSA is seeking comment on test speeds. Should test speeds for either of the head or leg tests be increased in an attempt to provide better protection to pedestrians in vehicle to pedestrian crashes? Should the area of assessment be increased beyond the WAD 2100 mm currently proposed to account for pedestrian heads overshooting the hood and impacting the windshield or the roof of the vehicle? [8]

In this proposal, the Agency is proposing to adopt the Euro NCAP crashworthiness pedestrian protection test devices, test procedures, and some (not all) of the scoring methods. Since the December 2015 notice, there were several updates to Euro NCAP procedures. NHTSA is proposing to adopt the following test procedures and versions:

(1) Euro NCAP Pedestrian Testing Protocol, Version 8.5, October 2018. This protocol describes vehicle preparation, test devices, qualification procedures, and test procedures.[105] As discussed later in this notice, NHTSA would conduct the headform test described in Section 12 of the Euro NCAP testing protocol, the upper legform to WAD775 tests described in Section 11 of the Euro NCAP testing protocol, and the FlexPLI to bumper tests described in Section 9 of the Euro NCAP testing protocol. NHTSA would not conduct the upper legform to bumper tests described in Section 10 of the Euro NCAP testing protocol.

(2) Euro NCAP Assessment Protocol—Vulnerable Road User Protection, Part 1—Pedestrian Impact Assessment, Version 10.0.3, June 2020. Once vehicle test data is collected, this document can be used to determine a resulting score.[106]

(3) Euro NCAP Pedestrian Headform Point Selection, V2.1, October 2017. This Microsoft Excel file is used to generate verification points to be tested by NHTSA.[107]

(4) Euro NCAP Film and Photo Protocol, Chapter 8—Pedestrian Subsystem Tests, V1.3, January 2020. This document describes the camera set-up procedure only.[108]

(5) Euro NCAP Technical Bulletin, TB 008, Windscreen Replacement for Pedestrian Testing, Version 1.0, September 2009. This document describes exceptions on bonding agents when windshields are replaced during the course of a vehicle test series.[109]

(6) Euro NCAP Technical Bulletin TB 019, Headform to Bonnet Leading Edge Tests, Version 1.0, June 2014. This document describes a procedure for child headform testing under the special case when test grid points lie forward of the hood and within the grille or hood leading edge area.[110]

(7) Euro NCAP Technical Bulletin TB 024, Pedestrian Human Model Certification, V2.0, November 2019. This document lists various computer-aided engineering models that have been deemed acceptable for use by a vehicle manufacturer in demonstrating the operation and performance of an active hood.[111]

Items 5 and 6 from the above list have not been updated since the December 2015 proposal, and therefore the same versions of these documents, which were proposed in 2015, are being proposed again in this notice. Items 1, 2, 3, and 4 have been updated since NHTSA's 2015 RFC, and therefore NHTSA is proposing the current versions of these documents at this time for incorporation into NCAP. NHTSA requests comment on the seven Euro NCAP documents proposed in section IV. F. (Euro NCAP Pedestrian Testing Protocol Version 8.5, Euro NCAP Assessment Protocol—Vulnerable Road User Protection Part 1—Pedestrian Impact Assessment Version 10.0.3, Euro NCAP Pedestrian Headform Point Selection V2.1, Euro NCAP Film and Photo Protocol Chapter 8—Pedestrian Subsystem Tests V1.3, Euro NCAP Technical Bulletin TB 008 Windscreen Replacement for Pedestrian Testing Version 1.0, Euro NCAP Technical Bulletin TB 019 Headform to Bonnet Leading Edge Tests Version 1.0, and Euro NCAP Technical Bulletin TB 024 Pedestrian Human Model Certification V2.0)—do any elements of these documents need modification for the U.S. NCAP? [9]

There are two notable differences from the list of documents proposed in 2015 compared to the list in this notice. The first is the removal of the Pedestrian Testing Protocol V5.3.1 that the Agency proposed in 2015 to address instances where a vehicle manufacturer did not provide NHTSA its test point data. This protocol was removed from the list because the proposed crashworthiness pedestrian protection protocol will be a self-reporting program in which a vehicle manufacturer will provide NHTSA with test data in order for a vehicle to be awarded credit. Thus, this document is no longer relevant.

The second notable change from the 2015 document list is the replacement

[103] Reproduced from GTR 9 Amendment 2 Figure 5B.

[104] Reproduced from GTR 9 Amendment 2 Figure 5C.

[105] *https://cdn.euroncap.com/media/41769/euro-ncap-pedestrian-testing-protocol-v85.201811091256001913.pdf.*

[106] *https://cdn.euroncap.com/media/58230/euro-ncap-assessment-protocol-vru-v1003.pdf.*

[107] *https://cdn.euroncap.com/media/30651/euro-ncap-pedestrian-point-selection-v21.xlsm.*

[108] *https://cdn.euroncap.com/media/57993/euro-ncap-film-and-photo-protocol-v13.pdf.*

[109] *https://cdn.euroncap.com/media/1352/tb-008-windscreen-replacement-v10-0-b4576306-91fe-4aa9-bf9c-5e5d0883e95e.pdf.*

[110] *https://cdn.euroncap.com/media/1367/tb-019-headform-to-ble-v10-0-94085bc9-76d7-4dab-af81-e59e9ed747aa.pdf.*

[111] *https://cdn.euroncap.com/media/56949/tb-024-pedestrian-human-model-certification-v20.pdf.*

of Technical Bulletin (TB) 013 with Technical Bulletin (TB) 024 (item 7 above). Both of these documents discuss computer models used to validate active hoods used for head-to-hood impact tests. NHTSA requests comment on TB 024 and its relevance to the U.S. NCAP. Should the models and methods in TB 024 or some other method be used to calculate head impact times to evaluate vehicles with active hoods? [10]

Although this proposal is to follow the Euro NCAP procedures with some proposed changes, NHTSA plans to generate its own test procedures and associated documents in the near future based on public input received from this notice and release these documents concurrent with the final decision notice. The documents will include additional requirements for contract test laboratories and will be formatted similarly to other NCAP test procedures and reference documents. Below are details of differences between the U.S. NCAP and Euro NCAP pedestrian protection testing protocols and evaluation methods.

1. Differences From Euro NCAP Tests and Assessment Protocols

NHTSA proposes to use the Euro NCAP testing protocol to conduct its assessment on all selected vehicles, including pickup trucks and large SUVs. For the most part, the procedures of Euro NCAP Testing Protocol V8.5 are applicable to all vehicles eligible for testing under the U.S. NCAP (vehicles with a gross vehicle weight rating less than or equal to 4,536 kilograms). This includes headform testing on grid points forward of the hood (or bonnet) leading edge (BLE), where the procedure stipulates an impact angle of 20 degrees relative to the ground. However, some adjustments to the Euro NCAP testing protocol are needed to align with the self-reporting aspect of the proposed program in U.S. NCAP, to better reflect pedestrian protection provided by the vehicle's front end, and to improve test practices.

a. Self-Reporting Data

In Euro NCAP, manufacturers typically self-report predicted head impact test data of their vehicles prior to Euro NCAP conducting its impact testing on those vehicles. However, upper leg and lower leg impact test data are not provided by the manufacturer. Instead, these data are gathered from the testing conducted by the Euro NCAP test facilities. For now, the U.S. NCAP proposes to operate its crashworthiness pedestrian protection program in a fully self-reported manner—similar to the Agency's crash avoidance testing program. Therefore, vehicle manufacturers would be expected to report all predicted head, upper leg, and lower leg impact test data to NCAP in order to receive crashworthiness pedestrian protection credit for their vehicles. NHTSA seeks comment on what level of detail should be required for self-reported data. Should manufacturers be allowed to submit predicted head and leg response data, or only actual physical test results? Should reporting consist of just the results for each test location, or should full data traces or a comprehensive test report including photographs and videos be required? [11]

b. No ''Blue Points'' for Predicted Head Impact Test Data

In Euro NCAP, manufacturers may elect to nominate some ''blue points'' as part of the predicted head impact test data. Blue grid points are those where pedestrian protection performance measure is unpredictable,[112] as indicated by the test results provided by the manufacturer. Due to the unpredictable nature of these grid points, the manufacturer does not include blue points in computing the overall score for the head impact testing assessment submitted to Euro NCAP. Euro NCAP always tests the identified blue points (instead of randomly selecting grid points) and includes the head impact assessment at these blue points in computing the overall head impact score. For the U.S. NCAP program, in order for a manufacturer to self-report that its vehicle meets the NCAP performance criteria and receives crashworthiness pedestrian protection credit, the manufacturer must have sufficient data to support a predicted point/color value for every head grid point and every upper and lower leg impact test point.

c. Use of FlexPLI on Pickup Trucks and Large SUVs

For this proposal, all vehicles would be tested with the FlexPLI, including pickup trucks, vans, and SUVs where a vehicle's LBRL is equal to or greater than 425 mm and less than or equal to 500 mm. As discussed previously, when the lower bumper reference line of a vehicle equals or exceeds 425 mm but is less than or equal to 500 mm, Euro NCAP allows manufacturers the option to test with the TRL upper legform instead of the FlexPLI. However, the Agency proposes to use the FlexPLI even if a vehicle's LBRL equals or exceeds 425 mm but is less than or equal to 500 mm. The option to test with either legform could lead to a situation where a high-bumper vehicle, such as a pickup truck, receives a similar score as a low-bumper vehicle even though the two vehicles could be subjected to two different test devices and test procedures. Furthermore, allowing the option to use different test devices could generate conflicting or misleading scores since the test parameters and test devices used to generate the scorings are not the same. Thus, in an effort to provide consumers with comparative vehicle safety information, NHTSA believes that vehicles should be subjected to the same test devices, testing protocols, and evaluation methods.

d. No Bumper Testing When LBRL Is Greater Than 500 mm

For vehicles that have an LBRL value of greater than 500 mm, the Agency does not propose to conduct a bumper assessment using the FlexPLI. Instead, the Agency proposes to simply assign a ''default red, no points'' score to the particular point under assessment (*e.g.,* some bumper points may be above 500 mm and not tested while others may be equal to or below 500 mm and tested). In 2009, the Insurance Institute for Highway Safety (IIHS) measured bumper heights for 68 light trucks and vans (LTVs or pickups, SUVs, and vans).[113] Fourteen vehicles (20 percent) that were measured had a height from ground to the bottom of the bumper equal to or greater than 500 mm. NHTSA also collected bumper height data on select MY 1989–1998 vehicles for its Pedestrian Crash Data Study (PCDS).[114] That study, which included both passenger cars and LTVs, showed that over 95 percent of vehicles measured had lower bumper heights (under 500 mm). The PCDS data set also identified approximately 20 percent of LTVs with bumper heights above 500 mm, closely matching the IIHS data. NHTSA expects that all passenger cars would have bumper heights less than 500 mm and be eligible for FlexPLI bumper testing. Only certain large SUVs and pickups would have bumper heights above 500 mm and thus those vehicles would not be eligible for FlexPLI bumper testing.

The Agency notes that the Euro NCAP testing protocol specifies that the TRL upper legform must be used when a

[112] Blue grid points are limited to the following structures: plastic scuttle, windscreen wiper arms and windscreen base, headlamp glazing, and break-away structures.

[113] *https://www.regulations.gov/comment/NHTSA-2009-0047-0010.*

[114] *https://www.regulations.gov/document/NHTSA-2019-0112-0016.*

vehicle's LBRL exceeds 500 mm, and that there is no option to use the FlexPLI for testing. Similar to NHTSA's rationale on its procedures, when a vehicle's LBRL equals or exceeds 425 mm but is less than or equal to 500 mm, the Agency believes that using the upper legform in lieu of the FlexPLI could result in an inaccurate or misleading bumper score. Furthermore, NHTSA is proposing to use the TRL upper legform for the WAD775 test as it is used in Euro NCAP. Thus, using the TRL upper legform for bumper testing when the LBRL exceeds 500 mm would result in a test redundancy because the WAD775 upper legform test and the ''in lieu of the FlexPLI'' upper legform test would be carried out on target points that are very close together.

As briefly discussed before, NHTSA believes that assessing the bumper using the FlexPLI when a vehicle's LBRL is greater than 500 mm is not an appropriate use of the test device. Such a test condition is beyond the limits for which the FlexPLI serves as a useful tool, which is also why it is not used in GTR 9 when a vehicle's LBRL exceeds 500 mm.[115] If a FlexPLI test is conducted on such a bumper, the legform's lack of an upper body structure could result in a condition where, upon impact, it is redirected groundward with very little tibia bending and knee displacement, thus leading to an artificially high test score. Such kinematics do not represent a human-to-vehicle interaction. In a real-world situation, bumpers that strike above the knee level cause the upper body and lower leg to rotate in opposite directions, which increases the likelihood of severe knee trauma.[116] Therefore, NHTSA believes that vehicles with an LBRL of 500 mm or higher should be given ''default red, no points'' for the bumper assessment. NHTSA would still conduct the WAD775 assessment with the upper legform. NHTSA requests comment on whether vehicles with an LBRL greater than 500 mm should be eligible to receive crashworthiness pedestrian protection credit because they will automatically receive a zero score for the FlexPLI bumper tests. [12]

e. Addressing Artificial Interference in High-Bumper Vehicles

When testing a high-bumper vehicle, the WAD775 mark may appear on the grille of the vehicle, well below the bonnet leading edge. In this instance, the TRL upper legform is propelled horizontally into the front face of the vehicle's front-end with contact points along the entire impactor, from top to bottom. If the front-end of a vehicle is not completely flush with protruding design elements, it could lead to a condition in which either the top or bottom edge of the impactor would just ''catch'' a protruding vehicle component, such as the top edge of the bumper—as shown in Figure 12. When this occurs, the impactor could glance off the component in such a way that it could absorb a significant amount of impactor energy without registering a significant moment or force in the instrument. This situation is an artifact of the component test and does not represent real-world vehicle-to-pedestrian interaction. The Agency encountered this situation when it tested the 2015 Ford F–150. In this proposal, if this situation occurs during a test, NHTSA will eliminate the effect by re-positioning the upper legform and moving it up or down the WAD line to a ''worst-case'' position that is no greater than +/- 50 mm from the WAD775 target. A worst-case position would be chosen such that the likelihood of a glancing blow would be minimized, and the impact energy would be maximized. NHTSA expects that most interference will come from the top edge of a bumper on a high bumper vehicle, thus the upper legform would be moved upward to avoid interference with the bumper. Multiple impacts could also be performed within +/- 50 mm from the WAD775 target and the worst-case result could be used for that impact point. NHTSA requests comment on the proposal to reposition the upper legform +/- 50 mm from the WAD775 target when artificial interference is present or to conduct multiple impacts within +/- 50 mm from the WAD775 target and use the worst-case result when artificial interference is present. [13]

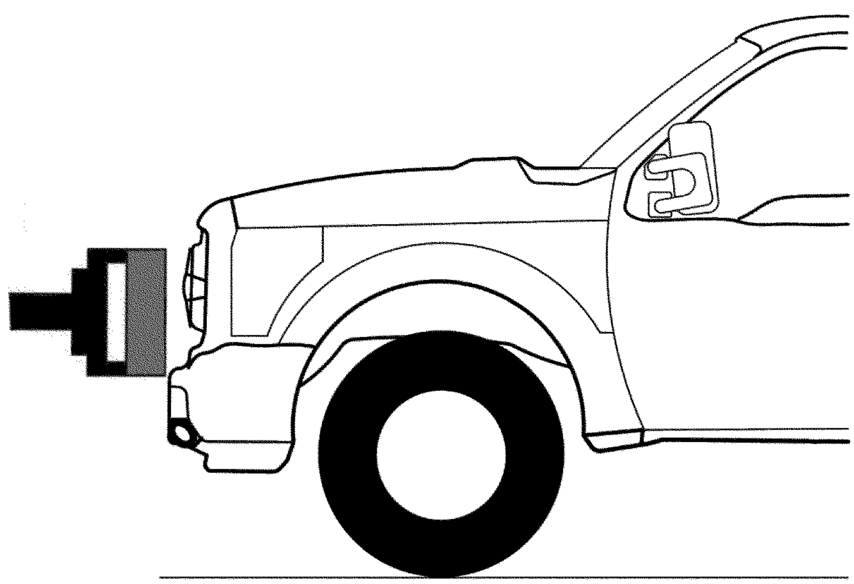

Figure 12: Upper Legform to WAD775 Glancing Blow

[115] See ''Rationale for limiting the lower legform test'' paragraph 99 of GTR 9.

[116] Simms C and Wood D (2009), ''Pedestrian and cyclist impact: a biomechanical perspective,'' Springer, IBSN 978–90–481–2742–9, Dordrecht, London, Heidelberg, New York, 2009.

f. Revised Bumper Corner Definition

In the Euro NCAP test protocol, the width of the FlexPLI test area is defined by the point of contact of a 60-degree plane and the forward-most point on the vehicle front-end (shown in Figure 9). Until 2016, the same definition was used in European pedestrian regulations that resulted in a vehicle design trend in which protruding ''touch points'' are molded into the lower portion of the fascia.[117] The touch points may be placed strategically to contact the 60-degree plane as a means for vehicle manufacturers to control the width of the test area. In some models, the touch points reduce the test area to as little as 40 percent of the vehicle width.

An analysis of pedestrian casualty data from the United Kingdom (U.K.) and Germany showed that vehicle-to-pedestrian contacts were distributed across the width of the vehicle, and pedestrians who were struck by a vehicle could receive leg injuries from all areas of the vehicle front-end.[118] In fact, it was not obvious that any one area was particularly safe or injurious. NHTSA believes that the same situation exists in the U.S.

In 2016, UNECE R127 was amended to include a new procedure that utilizes a corner gauge and diminishes the width-reducing effects of fascia touch points—as previously shown in Figure 10 and Figure 11. The new procedure also includes a specification to ensure that the entire width of the bumper beam (the very stiff structure underlying the fascia) is included in the test area. This bumper beam width requirement has also been included in the Euro NCAP test protocol since 2013, though Euro NCAP does not utilize the corner gauge. NHTSA tentatively plans to use the corner gauge and bumper beam width procedure for corner definition for this NCAP proposal and requests comment on this change. [14]

g. FlexPLI Qualification

In UNECE R127, the specifications for the FlexPLI qualification requirements involve a dynamic Pendulum test, a dynamic Inverse Impact test, and quasi-static force-deflection tests. However, in Euro NCAP, only the Inverse Impact and quasi-static tests are specified. For this proposal, NHTSA proposes to specify only the Pendulum test and quasi-static tests. As mentioned previously, NHTSA found the Pendulum test procedure easy to administer while vehicle testing is in progress. Also, the Agency is satisfied that the proposed qualification test assures the legform is performing correctly before resuming vehicle tests. NHTSA seeks comment on whether there is benefit in requiring both the Pendulum and Inverse Impact dynamic qualification tests in addition to the quasi-static tests. Also, what should the qualification test schedule for the FlexPLI be? For instance, the Pendulum test would be performed before every vehicle test series and the quasi-static qualification tests would be performed on an annual basis. [15]

h. Active Hood Detection Area

For vehicles with active hoods, the Agency would require manufacturers to demonstrate that their system does activate when there is a leg-to-bumper impact both at the vehicle centerline and as far outboard as the outboard end of the bumper test zone. This is the same requirement in the Euro NCAP test procedure. However, NHTSA would utilize the revised corner definition discussed above when determining the outboard end of the bumper test zone. Having said that, the Agency notes that the Informal Working Group for Deployable Pedestrian Protection Systems (IWG–DPPS) is actively meeting and discussing alternative definitions for the detection zone.[119] The IWG–DPPS is also investigating the use of the Flex-PLI in place of the Pedestrian Detection Impactor 2 (PDI2) legform to check deployment of active hoods. Therefore, NHTSA seeks comment on what the required detection area should be for vehicles with active hoods. Additionally, which device should be used for assuring the system activates properly, the Flex-PLI or the PDI2? [16]

2. Injury Limits and Scoring Process

The Euro NCAP Assessment Protocol—Vulnerable Road User Protection, Part 1—Pedestrian Impact Assessment, Version 10.0.3, June 2020 document listed above describes the injury limits and scoring process for the crashworthiness pedestrian protection impact tests proposed in this notice. That process is also summarized in the paragraphs below.

Each group of component tests (*i.e.,* headform tests, upper legform tests, FlexPLI tests) are first scored individually; these component scores are then summed to determine a crashworthiness pedestrian protection score for each vehicle. The exact number of impact points varies depending on the geometry of a vehicle. For instance, there may be 200 head impact points on the hood, windshield, and A-pillars, 15 upper leg impact points on the forward edge of the vehicle's front-end, and 15 lower leg impact points on the vehicle's bumper area. Each impact point for each test device is scored between 0 and 1 point depending on the resulting injury values from the impact test. Thus, each impact point for the head test carries equal weighting to every other impact point for the head. Each impact point for the upper leg carries equal weighting to every other impact point for the upper leg. Each impact point for the FlexPLI leg carries equal weighting to every other impact point for the FlexPLI.

In Euro NCAP, the overall pedestrian crashworthiness score combines the results from the headform tests, TRL upper legform tests, and FlexPLI tests with a maximum score of 36.00 points. The scoring distribution is as follows: 24.00 points (66.67 percent) are apportioned to test results with the headforms, 6.00 points (16.67 percent) are allocated to the upper legform, and 6.00 points (16.67 percent) are allotted to the FlexPLI. As previously discussed, NHTSA's review of pedestrian injuries in the U.S. indicated that serious to fatal injuries (AIS 3 or higher) may more closely be represented by apportioning 37.5 percent (3⁄8 or 13.50 of 36.00 points) to the headform, 25 percent (2⁄8 or 9.00 of 36.00 points) to the upper legform, and 37.5 percent (3⁄8 or 13.50 of 36.00 points) to the FlexPLI.[120] Therefore, the Agency is proposing a maximum of 13.50 points for the headform tests, 9.00 points for the upper legform tests as shown, and 13.50 points for the FlexPLI tests—as shown in Table 9. The Agency proposes utilizing a modified 3⁄8, 3⁄8, 2⁄8 scoring apportionment for the head impacts, Flex PLI impacts, and upper leg impacts respectively for NCAP and requests comment on this proposal. [17]

[117] Fascia refers to the materials that cover a vehicle's bumper beam. The fascia is often made of plastic and includes decorative contours.

[118] TRL CPR1825 from the GTR 9 Bumper Test Area Task Force, 6th session: *https://wiki.unece.org/download/attachments/23101696/TF-BTA-6-09e.pdf.*

[119] More information including meeting minutes and presentations available at *https://wiki.unece.org/pages/viewpage.action?pageId=45383713.*

[120] DOT HS 812 658.

TABLE 9—APPORTIONMENT OF PEDESTRIAN IMPACT TEST SCORES

Component	Apportionment	Apportionment (percentage)	Maximum points
Head	3/8	37.5	13.50
Upper Legform	2/8	25.0	9.00
FlexPLI	3/8	37.5	13.50

Each of the head impact locations on a vehicle contribute equally to the component level sub-score for the head tests. The Euro NCAP assessment protocol designates a color and awards either 0.00, 0.25, 0.50, 0.75, or 1.00 point to each head impact location using the following criteria:

TABLE 10—HEADFORM SCORING

Color	HIC min.	HIC max.	Point value
Green	....	<650	1.00
Yellow	650	<1,000	0.75
Orange	1,000	<1,350	0.50
Brown	1,350	<1,700	0.25
Red	1,700	....	0.00

Thus, any HIC score that falls in the ''Green'' range will receive a point value of 1.00, any HIC score that falls in the ''Yellow'' range will receive a point value of 0.75, any HIC score that falls in the ''Orange'' range will receive a point value of 0.50, etc.

The head impact sub-score is calculated according to the following formula:

Equation 1: Head Component Sub-Score Calculation

$$\textit{Head Sub-Score} = \textit{Apportionment of Head Impacts}\left(\frac{\textit{Sum of All Head Impact Points}}{\textit{Total Number of Head Impact Points}}\right)$$

Each of the upper legform impact locations contributes equally to the component level sub-score for the upper legform impacts. Each impact location may be awarded up to 1.00 point on a linear sliding scale between the upper and lower injury limits. This is different than the headform scoring where injury values are put in discrete scoring bands. The worst-performing injury metric (one of three moments—upper, middle, or lower; or sum of forces) is used to determine the score using the following criteria:

TABLE 11—UPPER LEGFORM SCORING

Component	Min. injury	Max. injury	Max. point value
Bending Moment (Nm)	285	350	1.00
Sum of forces (N)	5000	6000	....

The upper legform scoring is shown graphically in Figure 13 and Figure 14. Injury values closer to the minimum injury values earn more points and injury values closer to the maximum injury values earn fewer points.

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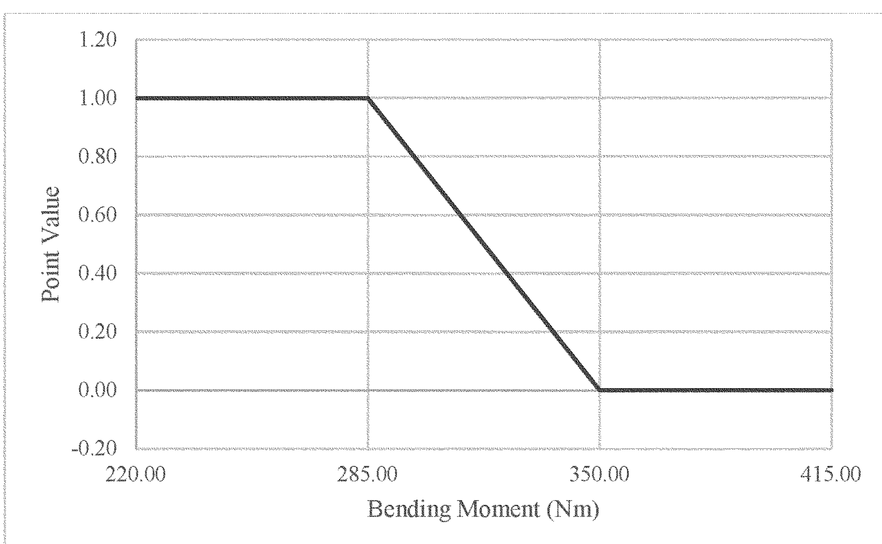

Figure 13: Upper Legform Bending Moment Scoring

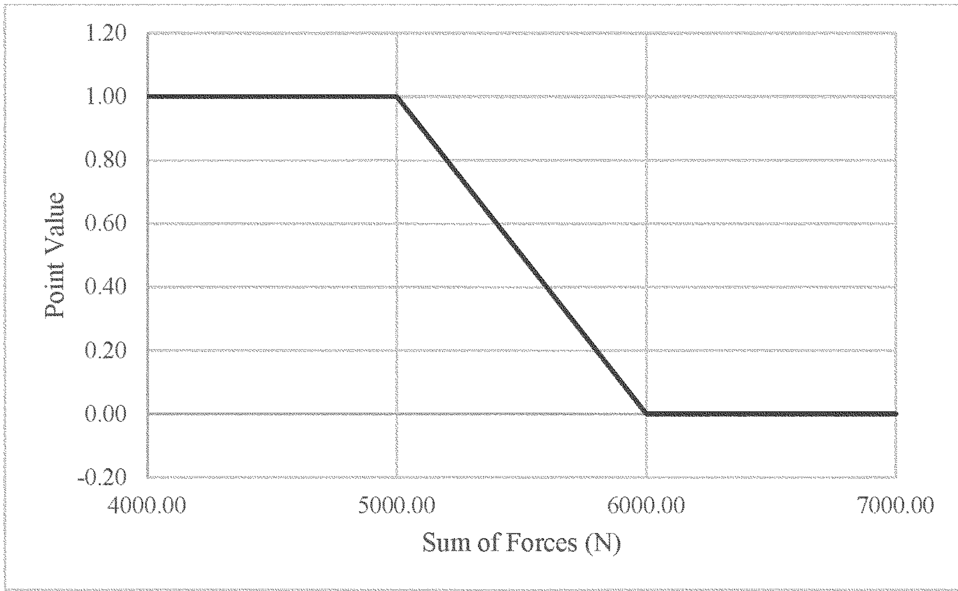

Figure 14: Upper Legform Sum of Forces Scoring

The upper legform impact sub-score is calculated according to the following formula:

Equation 2: Upper Leg Component Sub-Score Calculation

$$\text{Upper Leg Sub-Score} = \text{Apportionment of Upper Leg Impacts}\left(\frac{\text{Sum of All Upper Leg Impact Points}}{\text{Total Number of Upper Leg Impact Points}}\right)$$

Similarly, each of the FlexPLI impact locations on a vehicle contributes equally to the component level sub-score for the FlexPLI tests. Each impact location may receive up to 0.50 points from the tibia moments and up to 0.50 points from the ligament elongations. The tibia score is determined from the worst of the four tibia measurements—T1, T2, T3, or T4. The ligament elongation is scored from the MCL as long as neither the ACL nor PCL exceeds the 10 mm elongation limit. If either the ACL or PCL exceed this limit, the overall ligament elongation score is 0.00. Similar to the upper legform scoring, the Euro NCAP assessment protocol awards points based on a linear sliding scale between the upper and lower injury limits using the criteria in Figure 8. Again, this is different than the headform scoring method where injury values are put in discrete scoring bands.

TABLE 12—FLEXPLI SCORING

Component	Min. injury	Max. injury	Max. point value
Tibia bending (Nm)	282	340	0.50
MCL elongation (mm)	19	22	0.50
ACL/PCL elongation (mm)	....	10	0.00

The FlexPLI scoring is shown graphically in Figure 15 and Figure 16. Injury values closer to the minimum injury value earn more points, and injury values closer to the maximum injury value earn fewer points.

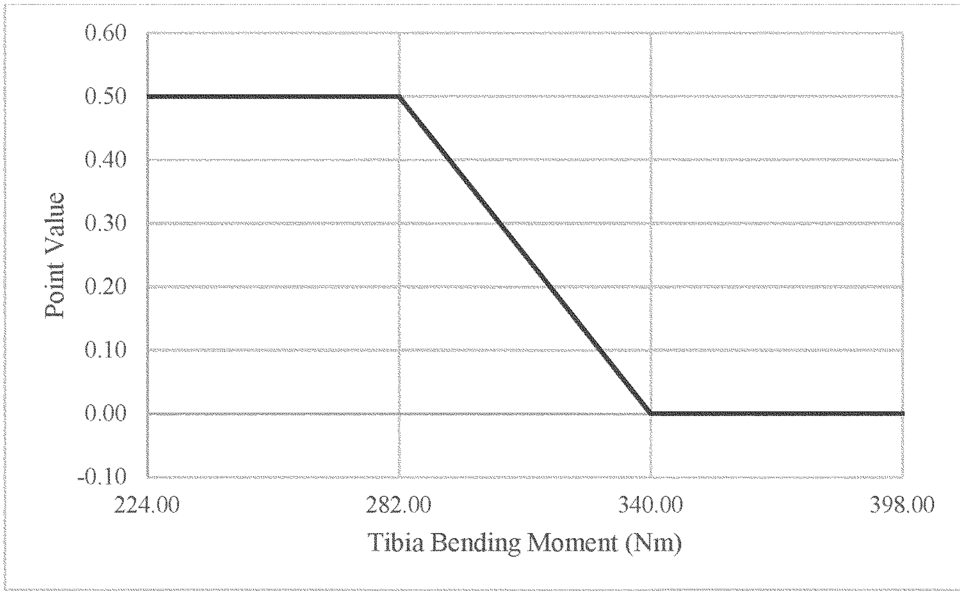

Figure 15: FlexPLI Tibia Bending Moment Scoring

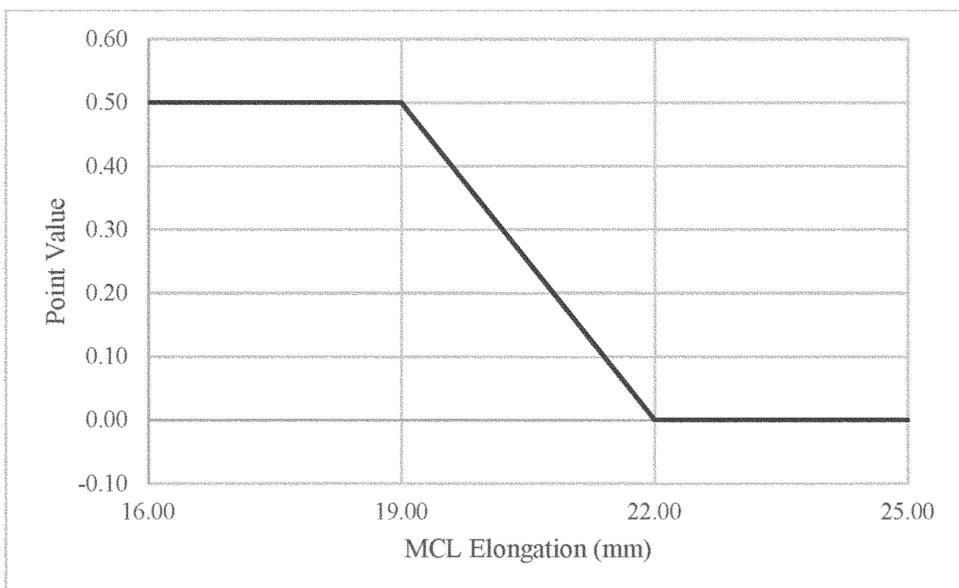

Figure 16: FlexPLI MCL Elongation Scoring

The FlexPLI impact sub-score is calculated according to the following formula:

Equation 3: FlexPLI Component Sub-Score Calculation

$$\mathit{FlexPLI\ Sub\text{-}Score} = \mathit{Apportionment\ of\ FlexPLI\ Impacts}\left(\frac{\mathit{Sum\ of\ All\ FlexPLI\ Impact\ Points}}{\mathit{Total\ Number\ of\ FlexPLI\ Impact\ Points}}\right)$$

The resulting crashworthiness pedestrian protection score is the summation of the three component sub-scores and is calculated according to the following formula:

Equation 4: NCAP Pedestrian Protection Score Calculation

$$\textit{Pedestrian Protection Score} = \textit{Head Component Sub-Score} + \textit{Upper Leg Component Sub-Score} + \textit{FlexPLI Component Sub-Score}$$

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3. NCAP Proposal for Awarding Credit

As stated earlier in this notice, NHTSA proposes to implement the crashworthiness pedestrian protection testing program initially by assigning credit to vehicles that meet NCAP performance test requirements before including them as part of a future rating system. In other words, instead of rating a vehicle's crashworthiness pedestrian protection on a scale of 1 to 5 stars, initially, NHTSA proposes to assign credit to vehicles if they meet a certain minimum scoring threshold for crashworthiness pedestrian protection. The Agency believes that consumers would still be able to compare crashworthiness pedestrian protection by identifying vehicles that have been designated by NHTSA as meeting this minimum level of pedestrian safety. Furthermore, this approach would not only allow early adopters to participate in the program, but also provide sufficient time for manufacturers to redesign their vehicles to improve pedestrian crashworthiness safety.

In Euro NCAP, a MY 2022 vehicle must receive a Vulnerable Road User (VRU) sub-score of 60 percent or greater to receive a 5-star overall vehicle safety rating, or 50 percent or greater to receive a 4-star overall vehicle safety rating. The VRU sub-score is a combination of crashworthiness pedestrian protection as well as pedestrian and pedalcyclist crash avoidance. Omitting the crash avoidance portion from the VRU score, a vehicle must score 21.60 points or greater in crashworthiness pedestrian protection to achieve the 60 percent threshold and receive a 5-star overall vehicle safety rating in Euro NCAP. Similarly, a vehicle must score 18.00 points or greater to attain the 50 percent threshold and receive a 4-star overall vehicle safety rating in Euro NCAP. For MY 2023 and beyond, Euro NCAP's assessment protocol will become more stringent. For instance, a 70 percent VRU score will be required to achieve an overall 5-star vehicle safety rating, and 60 percent VRU will be needed to earn an overall 4-star rating.[121] In terms of points, this would equate to 25.20 points for a 5-star overall rating, or 21.60 points for a 4-star overall rating.

TABLE 13—U.S. AND EUROPEAN FLEET PEDESTRIAN PROTECTION SCORES

	U.S. fleet scores (MY 2015–2017)		Euro NCAP vehicle scores (MY 2018–2021)	
	Points	Percentage	Points	Percentage
Headform (24.00 max.)	16.43	68	16.50	69
Upper Legform (6.00 max.)	3.52	59	4.06	68
Lower Legform (6.00 max.)	1.67	28	5.93	99
Overall (36.00 max.)	21.63	60	26.49	74

NHTSA reviewed approximately 100 European vehicles rated by Euro NCAP from model years 2018 to 2021 for crashworthiness pedestrian protection—as shown in Table 13 above. Of those vehicles, the average overall score for all three tests was 26.49 points out of a possible 36.00, or 74 percent, and only one vehicle had an overall score of less than 21.60 points (60 percent). At a component level, the average score was 16.50 out of a possible 24.00 points for the head tests, 4.06 out of a possible 6.00 for the upper legform impact test, and 5.93 out of a possible 6.00 for the lower leg impact test. The upper legform impact test had the most variable scores as many vehicles received a perfect 6.00 points, but many vehicles also received 0.00 points.

NHTSA also evaluated nine U.S. vehicles from model years 2015 to 2017 using head impact tests, upper leg impact tests, and lower leg impact tests.[122] Also, as illustrated in Table 13, of the nine vehicles tested, the average overall score was 21.63 points out of 36.00 points, or 60 percent. Overall scores ranged from 11.02 to 30.12 points. Four of the nine vehicles scored less than 21.60 points, or 60 percent. For the head component testing, vehicles in the NHTSA evaluation scored an average of 16.43 points out of a possible 24.00 points. As shown in Table 13, the average head score of 16.43 points for NHTSA's fleet testing of U.S. vehicles is only slightly less than the Euro NCAP average head score of 16.50 points. For the upper legform testing, the U.S. fleet scored an average of 3.52 points and the European fleet scored an average of 4.06 points. Although these two averages are similar, the European data has a median score of 4.06 points, and many vehicles received high scores for the WAD775 tests while some vehicles received very low scores, which brought the average score down. For the lower legform testing, NHTSA fleet testing also had low scores from

[121] See Euro NCAP Assessment Protocol—Overall Rating v9.1. *https://cdn.euroncap.com/media/64096/euro-ncap-assessment-protocol-overall-rating-v91.pdf.*

[122] DOT HS 812 723.

the U.S. fleet vehicles with an average of 1.67 points out of a maximum of 6.00 points while the 100 vehicles rated by Euro NCAP had an average of 5.93 points—nearly perfect.

TABLE 14—U.S. AND EUROPEAN FLEET PEDESTRIAN PROTECTION SCORES USING A MODIFIED SCORING SYSTEM

	U.S. fleet scores (MY 2015–2017)		Euro NCAP vehicle scores (MY 2018–2021)	
	Average points	Percentage	Average points	Percentage
Modified 3⁄8, 3⁄8, 2⁄8 Scoring				
Headform (13.50 max.)	9.24	68	9.28	69
Upper Legform (9.00 max.)	5.29	59	6.09	68
Lower Legform (13.50 max.)	3.76	28	13.35	99
Overall (36.00 max.)	18.29	51	28.72	80

Table 14 presents the same nine U.S. fleet vehicles and approximately 100 Euro NCAP vehicles but with the proposed 3⁄8, 3⁄8, 2⁄8 modified apportionment scoring for the U.S. NCAP program discussed earlier in this notice. As shown in the table, the spread in overall scoring between the existing U.S. vehicles and Euro NCAP vehicles is much wider. The overall score is reduced for the U.S. vehicles because more weight is distributed in the upper and lower leg impact tests, which perform poorly compared to the Euro NCAP vehicles. In this proposed apportionment method, less weight is assigned to the head impact tests, in which the U.S. vehicles' performance was comparable to the Euro NCAP vehicles. The data not only shows that this modified apportionment of the component scores more closely reflect real-world AIS 3+ injuries in the U.S., but also highlights the disparity between the European and U.S. fleets and the need for additional safety improvements for the latter.

In order for a vehicle to be recognized by NHTSA as meeting the performance requirements for crashworthiness pedestrian protection, it must score at least 21.60 out of 36.00 points (or 60 percent) combined for the head, upper leg, and lower leg impact tests when tested and scored in accordance with the documents outlined in the previous section of this notice and the modified 3⁄8, 3⁄8, 2⁄8 apportionment scoring. Six of the nine vehicles NHTSA evaluated did not meet this minimum score, but all of the approximately 100 vehicles rated in Euro NCAP's published data met this minimum score with the modified apportionment.

As discussed previously, NHTSA proposes to implement this by initially awarding credit to vehicles that meet the Agency's performance requirements under NCAP. As the Agency is still considering the best approach to convey vehicle safety information on the Monroney label and developing a new rating system that will include several planned NCAP updates, NHTSA is not proposing changes to the Monroney label at this time. Therefore, NHTSA proposes to inform consumers of vehicles that receive crashworthiness pedestrian protection credit through its website, *http://www.NHTSA.gov.* This approach is very similar to the current crash avoidance testing program in NCAP. Currently, ADAS technologies are identified through the use of check marks on the Agency's website. NHTSA seeks comment on whether this is an appropriate way to identify vehicles that meet the Agency's minimum criteria for crashworthiness pedestrian protection, or if some other notation or identifying means is more appropriate.[18]

Currently, NHTSA reports vehicle safety ratings on a per-model basis, with separate ratings for different drivetrains due to differences in rollover resistance. For the crashworthiness testing program in NCAP, vehicles are tested without optional safety equipment. For the crash avoidance testing program, vehicles that are equipped with an ADAS technology as standard equipment are noted as such, as are vehicles that have the same technology as optional equipment. NHTSA notes that for the proposed crashworthiness pedestrian protection program, there may be other factors to consider, such as trim lines or other vehicle options that may affect the performance of the vehicle's countermeasures. NHTSA anticipates that trim lines or options that change the ride height of the vehicle, the clearance under the hood, or the shape of the headlights may have significant effects on the outcome of the crashworthiness pedestrian protection tests. NHTSA seeks comment on what options or features might exist within the same vehicle model that would affect the vehicle's performance of crashworthiness pedestrian protection. NHTSA also seeks comment on whether the Agency should assign credit to vehicles based on the worst-performing configuration for a specific vehicle model, or if vehicle models with optional equipment that affect the crashworthiness pedestrian protection credit should be noted as such.[19]

4. NCAP Verification Testing

NHTSA believes that in order to maintain the integrity of the NCAP program and public trust, the Agency must not rely solely upon manufacturer self-reported data but must also implement a verification testing process—similar to the crash avoidance testing program in NCAP. Therefore, NHTSA is proposing the following processes for the crashworthiness pedestrian protection program.

If a manufacturer believes that a vehicle model meets the minimum criteria outlined above and wishes to self-report that vehicle for crashworthiness pedestrian protection credit, the manufacturer must submit test data to NHTSA in a standardized format developed by NHTSA. This process is consistent with the process for the crash avoidance testing program that NCAP has evaluated for a number of years. As mentioned previously in this notice, the manufacturer would need to submit predicted scores for every head impact grid point and every upper and lower leg impact test location. NHTSA would review this information for accuracy and completeness and award credit if the submitted data meet the minimum criteria outlined previously.

For each new model year, NHTSA selects and acquires vehicles for testing under NCAP. Consistent with the processes used in the crash avoidance testing program, NHTSA proposes to select and acquire new model year vehicles for verification testing of their crashworthiness pedestrian protection performance. As part of NCAP, NHTSA proposes to select only vehicles with test data submitted by the manufacturers and approved by NHTSA as meeting the minimum performance criteria for crashworthiness pedestrian protection.

For the crashworthiness pedestrian protection testing program, NHTSA is proposing to test a number of head impact points, upper leg impact test locations, and lower leg impact test locations on each vehicle that is selected for verification testing under NCAP.

NHTSA proposes to use the manufacturer's supplied predicted head impact test data in conjunction with the data collected during the verification testing, similar to the process used by Euro NCAP. The resulting NCAP data would be compared to the manufacturer's predicted data to determine a correction factor to apply to the entire head impact test data set. If the sum of the NHTSA test scores is lower than the sum of the manufacturer predicted scores, then the manufacturer predicted scores are multiplied by a factor less than 1.0. If the sum of the NHTSA test scores is higher than the sum of the manufacturer predicted scores, then the manufacturer predicted scores are multiplied by a factor greater than 1.0. If the sums of the scores are the same, the correction factor is 1.0, and thus the manufacturer's predicted head scores would not be modified. An example of this scoring method is given later in this notice.

NHTSA also proposes to conduct FlexPLI and upper leg impact testing across the entire width of the vehicle utilizing symmetry and adjacency. Symmetry and adjacency are concepts also utilized in Euro NCAP bumper and WAD775 testing with the FlexPLI and upper legform. In order to reduce test burden, it is assumed that a vehicle's front end is symmetrical, and thus the test result on a specific point on one side of the vehicle will also be applied to that same point on the other side of the vehicle. Likewise, an untested point would receive the same score as the lowest scored adjacent point. Typically, complete FlexPLI and upper legform scores can be determined with just four impacts for each test using symmetry and adjacency methods.

After NHTSA completes verification testing, the resulting data from the legform impact tests would replace the manufacturer-supplied data for that model. The data from the upper leg, lower leg, and head impact tests (with correction factor applied) would be used to generate a new crashworthiness pedestrian protection score for that vehicle model. If that score still meets NHTSA's minimum requirement for NCAP crashworthiness pedestrian protection (60 percent), the model would maintain its credit. If the new score no longer meets the minimum, that vehicle would have its credit removed.

NHTSA is proposing to test ten head impact points as part of the verification testing process, consistent with the Euro NCAP test procedure. As stated before, NHTSA does not propose to allow ''blue points'' in this proposed program, so all 10 test points would be chosen from the entire pool of head impact test locations. NHTSA believes that, for most vehicles, three or four upper leg impact points and three or four FlexPLI impact points would be necessary to generate a complete score for the bumper and WAD775. Thus, the Agency proposes to conduct either three or four tests with each device, as appropriate, for a given vehicle model.

The Euro NCAP test procedures cited previously in this notice outline an acceptable HIC tolerance for the head impact tests. NHTSA proposes to utilize this established tolerance for the proposed head impact tests under NCAP (see Table 15 below). Self-reported data from a manufacturer would be submitted to NHTSA in a specific HIC ''color band''; each color band would have a 10 percent tolerance for verification testing. If NHTSA conducts a verification test on a selected head impact grid point and the resulting HIC value falls outside of the acceptable HIC range for the predicted color band, that point would be changed to the corresponding color band. After all 10 verification tests for the head impact test are complete, the resulting score for those 10 locations would be compared to the manufacturer's predicted score for the 10 locations. A correction factor would be determined (Equation 5) and applied to the entire head test zone, excluding default red and default green locations—similar to the method used in Euro NCAP (Equation 6). A detailed example of the head impact verification test is provided in appendix B.

TABLE 15—ACCEPTABLE HIC RANGE FOR VERIFICATION TESTING

Predicted color band	HIC_{15} range	Acceptable HIC_{15} range
Green	$HIC_{15} < 650$	$HIC_{15} < 722.22$
Yellow	$650 \leq HIC_{15} < 1{,}000$	$590.91 \leq HIC_{15} < 1{,}111.11$
Orange	$1{,}000 \leq HIC_{15} < 1{,}350$	$909.09 \leq HIC_{15} < 1{,}500.00$
Brown	$1{,}350 \leq HIC_{15} < 1{,}700$	$1{,}227.27 \leq HIC_{15} < 1{,}888.89$
Red	$1{,}700 \leq HIC_{15}$	$1{,}545.45 \leq HIC_{15}$

Equation 5: Correction Factor for Head Impact Tests

$$Correction\ Factor = \frac{Sum\ of\ actual\ test\ scores}{Sum\ of\ predicted\ scores}$$

Equation 6: Corrected Head Sub-Score Equation

$$\begin{aligned} &Corrected\ Head\ Sub\text{-}Score \\ &= (Head\ Sub\text{-}Score - Default\ Green - Default\ Red) * Corection\ Factor \\ &+ Default\ Green + Default\ Red \end{aligned}$$

Unlike the head impact tests, NHTSA would not use a correction factor for the upper leg impact and lower leg impact tests. Instead, NHTSA would conduct a complete set of tests with each test device and determine a resulting score for the bumper and WAD775 using the established rules of symmetry and adjacency. The NHTSA-derived scores for the WAD775 (upper leg) and bumper (lower leg) would be used in conjunction with the corrected hood (head) score (calculated according to Equation 6) to determine a new crashworthiness pedestrian protection score for the vehicle model. If the resulting score continues to be 60 percent or greater, the vehicle would maintain its crashworthiness pedestrian protection credit status. Otherwise, that credit would be removed. NHTSA seeks comment on the proposal to conduct verification testing as part of the crashworthiness pedestrian protection program by adjusting the head score using a conversion factor determined from laboratory tests and replacing manufacturer supplied FlexPLI and upper leg scores with NHTSA scores from laboratory tests. [20]

V. Conclusion

This RFC proposes to add a crashworthiness pedestrian protection testing program to NCAP. In doing so, it responds to comments received on pedestrian safety to previous NCAP RFCs and seeks comment on a program that would accept self-reported data from vehicle manufacturers and conduct verification testing on select new model year vehicles each year. Finally, when adopted, the changes proposed in this notice would fulfill the mandate set forth in the BIL to amend NCAP to provide the public with important safety information regarding the protection of vulnerable road users.

VI. Economic Analysis

The changes to NCAP proposed in this RFC would ultimately enable a rating system that improves consumer awareness of crashworthiness pedestrian protection systems and the improvements to safety that stem from those systems and encourage manufacturers to accelerate their adoption. The accelerated adoption of pedestrian protection systems 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 pedestrian protection systems proposed for inclusion in NCAP and the potential benefit of eventually developing a new rating system that would include this information.

Crashworthiness pedestrian protection systems are unique because the safety improvements are attributable to improved *pedestrian* protection, as opposed to improvements in *occupant* protection that the other crashworthiness components in NCAP provide. Unlike advanced driver assistance systems, their effectiveness is the reduction of pedestrian injury and prevention of pedestrian fatalities when a crash between a motor vehicle and pedestrian does occur. This effectiveness is typically measured by using a combination of real-world statistical data, laboratory testing, and Agency expertise.

As discussed in detail in this notice, crashes between pedestrians and motor vehicles present significant safety issues and NHTSA is particularly concerned about the steady rise in pedestrian fatalities over the last several years. The data from countries that prioritize crashworthiness pedestrian protection systems, via both regulation and other consumer information programs, indicate that these systems are effective in reducing pedestrian injuries and fatalities. BASt in Germany found a correlation between Euro NCAP pedestrian protection scores and pedestrian injuries and fatalities. The Swedish Transport Administration also found that vehicles that score better in the Euro NCAP pedestrian crashworthiness tests tended to reduce injury in actual crashes. Although these studies have been limited to certain geographic areas, which may not represent the entire U.S. 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 systems 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 crashworthiness pedestrian protection systems.

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. Regarding consumer information, the introduction of a potential new component to the NCAP rating system is anticipated to provide consumers additional vehicle safety information regarding the safety of vulnerable road users to help them make more informed purchasing decisions by presenting the relative safety benefits of systems designed to protect not only occupants inside the vehicle but also persons outside the vehicle. While NHTSA knows that consumers value information about the protection of vehicle occupants when making purchasing decisions, the Agency believes that as a society, most consumers are also interested in protecting people that share their roads. Hence, there is an unquantifiable value to consumers and to the society as a whole for the Agency to provide accurate and comparable vehicle safety information about protecting all lives. At this time, the Agency does not have sufficient data, such as unit cost and information on how soon the full adoption of pedestrian protections systems would be reached, to predict the net increase in cost to consumers with a high degree of certainty.

VII. 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 C 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, submit these materials to NHTSA's Office of the Chief Counsel in accordance with 49 CFR part 512. All requests for confidential treatment must be submitted directly to the Office of the Chief Counsel. NHTSA is currently treating electronic submission as an acceptable method for submitting confidential business information to the agency under part 512. If you claim that any of the information or documents provided in your response constitutes confidential business information within the meaning of 5 U.S.C. 552(b)(4), or are protected from disclosure pursuant to 18 U.S.C. 1905, you may submit your request via email to Dan Rabinovitz in the Office of the Chief Counsel at *Daniel.Rabinovitz@dot.gov,* or the legal contact listed under **FOR FURTHER INFORMATION CONTACT**. Do not send a hardcopy of a request for confidential treatment to NHTSA's headquarters.

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.*

VIII. Appendices

A. Additional Pedestrian Crash Data

TABLE 16—PEDESTRIANS KILLED BY NUMBER OF STRIKING VEHICLES 2011–2020

Year	Number of striking vehicles								
	1	2	3	4	5	7	8	20	Total
2011	4,365	77	15	0	0	0	0	0	4,457
2012	4,709	94	12	2	1	0	0	0	4,818
2013	4,658	99	18	2	1	0	0	1	4,779
2014	4,776	119	12	2	1	0	0	0	4,910
2015	5,373	112	5	1	2	0	1	0	5,494
2016	5,942	121	14	2	0	1	0	0	6,080
2017	5,938	124	11	2	0	0	0	0	6,075
2018	6,230	120	17	6	1	0	0	0	6,374
2019	6,132	125	14	1	0	0	0	0	6,272
2020	6,329	158	19	9	1	0	0	0	6,516
Total	54,452	1,149	137	27	7	1	1	1	55,775

Source: NHTSA Fatality Analysis Reporting System (FARS).

TABLE 17—PEDESTRIANS KILLED BY STRIKING VEHICLE BODY TYPE 2011–2020

Year	Vehicle body type					
	Passenger car	Light truck	Large truck	Bus	Other/ unknown vehicle	Total
2011	1,591	1,599	247	62	350	3,849
2012	1,817	1,698	231	68	368	4,182
2013	1,686	1,721	260	64	420	4,151
2014	1,778	1,817	226	73	379	4,273
2015	2,061	1,941	246	60	470	4,778
2016	2,228	2,217	297	46	533	5,321
2017	2,215	2,240	282	34	504	5,275
2018	2,314	2,286	325	45	538	5,508
2019	2,182	2,343	353	52	528	5,458
2020	2,160	2,199	379	38	760	5,536
Total	20,032	20,061	2,846	542	4,850	48,331
Totals grouped	40,093		3,388			

Note: this table filters by first harmful event = pedestrian and number of motor vehicles in transport = 1. Source: NHTSA FARS.

TABLE 18—PEDESTRIANS KILLED IN FRONTAL CRASHES 2011–2020

Year	Body type					
	Passenger car	Light truck	Large truck	Bus	Other/ unknown vehicle	Total
2011	1,463	1,421	168	42	190	3,284
2012	1,664	1,517	161	46	205	3,593

TABLE 18—PEDESTRIANS KILLED IN FRONTAL CRASHES 2011–2020—Continued

Year	Body type					
	Passenger car	Light truck	Large truck	Bus	Other/ unknown vehicle	Total
2013	1,559	1,533	182	45	229	3,548
2014	1,610	1,625	168	47	227	3,677
2015	1,860	1,728	169	42	228	4,027
2016	1,980	1,943	222	27	270	4,442
2017	1,997	1,997	207	25	267	4,493
2018	2,113	2,056	252	32	265	4,718
2019	1,976	2,093	255	34	280	4,638
2020	1,972	1,969	274	21	386	4,622
Total	18,194	17,882	2,058	361	2,547	41,042
Totals grouped	36,076		2,419			

Note: this table filters by first harmful event = pedestrian, number of motor vehicles in transport = 1, and impact point = front. Source: NHTSA FARS.

TABLE 19—PEDESTRIAN FATALITIES AND INJURIES WITH KNOWN TRAVEL SPEED 2011–2020

Speed	Fatalities 2011–2020			Injuries 2011–2020		
	Count	Cumulative count	Cumulative percentage	Count	Cumulative count	Cumulative percentage
0	315	315	1.5	5,179	5,179	2.7
1–25 mph	2,467	2,782	13.2	128,365	133,544	68.7
26–30 mph	1,505	4,287	20.3	15,497	149,041	76.7
31–35 mph	2,748	7,035	33.4	17,641	166,682	85.8
36–40 mph	2,880	9,915	47.1	9,115	175,797	90.5
41–45 mph	3,684	13,599	64.5	8,583	184,380	94.9
46–50 mph	1,604	15,203	72.2	2,438	186,818	96.2
51–55 mph	2,134	17,337	82.3	3,338	190,156	97.9
56–60 mph	1,055	18,392	87.3	1,088	191,244	98.4
61–65 mph	1,171	19,563	92.8	1,376	192,620	99.1
66–70 mph	845	20,408	96.9	935	193,555	99.6
71–75 mph	254	20,662	98.1	435	193,990	99.8
76–80 mph	120	20,782	98.6	138	194,128	99.9
81–151 mph	285	21,067	100.0	134	194,262	100.0
More than 151 mph	3	21,070	100.0	23	194,285	100.0

Source: NHTSA FARS and General Estimates System (GES).

TABLE 20—ROUNDED TOTAL PEDESTRIANS INJURED IN FRONT END CRASHES
[GES & FARS]

Year	Body type		
	Passenger car	Light truck	Total
2011	29,000	16,000	45,000
2012	32,000	18,000	50,000
2013	24,000	18,000	42,000
2014	26,000	17,000	43,000
2015	31,000	17,000	48,000
2016	37,000	23,000	60,000
2017	30,000	19,000	49,000
2018	30,000	21,000	51,000
2019	31,000	20,000	51,000
2020	23,000	16,000	39,000
Total	293,000	187,000	479,000

Note: Injury numbers are rounded because GES numbers are estimates. Source: NHTSA GES & FARS.

TABLE 21—PROBABILITIES FOR FATAL/SERIOUS INJURY AND EURO NCAP PEDESTRIAN SCORE

	Euro NCAP pedestrian score		
	5 Points	22 Points	Reduction (percent)
Fatal Injury probability (percent)	0.58	0.37	36

TABLE 21—PROBABILITIES FOR FATAL/SERIOUS INJURY AND EURO NCAP PEDESTRIAN SCORE—Continued

	Euro NCAP pedestrian score		
	5 Points	22 Points	Reduction (percent)
Serious Injury Probability (percent)	27.4	22.9	16

Source: Pastor, C. Correlation between pedestrian injury severity in real-life crashes and Euro NCAP pedestrian test results, In: Proceedings of the 23rd Technical Conference on the Enhanced Safety of Vehicles (ESV). Seoul, 2013.

TABLE 22—FLEXPLI IMPACT DATA FOR U.S. MARKET VEHICLES

	Tibia bending moment (IARV = 340 Nm)		MCL elongation (IARV = 22 mm)		ACL elongation (IARV = 13 mm (GTR) 10 mm (EuroNCAP))		
	Value (Nm)	% of IARV	Value (mm)	% of IARV	Value (mm)	% of IARV (GTR)	% of IARV (EuroNCAP) *
2013 Ford Fusion (Center)	250	74	18	82	7.2	55	72
2013 Ford Fusion (Outboard 1)	177	52	14.6	66	6.7	52	67
2013 Ford Fusion (Outboard 2)	184	54	15.1	69	7.4	57	74
2011 Chevrolet Cruze (Modified)	335	99	14.9	68	8.1	62	81
2006 Volkswagen Passat (Modified)	354	104	21.3	97	13.1	101	131

* **Note:** A comparison to Euro NCAP injury values was not done as part of the original study. It's included here for reference. Source: NHTSA Research.

TABLE 23—PART 581 TEST RESULTS FOR U.S. MARKET VEHICLES

Vehicle	Longitudinal impact (2.5 mph)		Corner impact (1.5 mph)		Non-bumper damage?
	Upper (B) + lower (A) plane force (N)	Mid-plane force (N)	Upper (B) + lower (A) plane force (N)	Mid-plane force (N)	
2013 Ford Fusion	704	17783	1043	24791	No.
2011 Chevrolet Cruze (Modified)	1861	24485	1527	24452	No.
2006 Volkswagen Passat (Modified)	1576	30048	770	15675	No.

Source: NHTSA Research.

TABLE 24—POTENTIAL EFFECTS OF TEST PROCEDURES ASSOCIATED WITH EACH PEDESTRIAN IMPACTOR

	MAIS 2+ (%)	MAIS 3+ (%)	MAIS 4+ (%)	Fatal cases (%)
Pedestrians Potentially Affected by Each Type of Test Procedure				
Headform Test	26.3	22.2	34.0	35.6
TRL Upper Legform Test	12.5	14.4	1.7	5.2
FlexPLI Test	31.0	22.0	0.4	1.8
Sum of Total Potential Effects for Component-Level Pedestrian Test Procedures				
Sum of Total Potential Effects From 3 Tests	69.9	58.6	36.1	42.6
Proportion of Total Effects by Test Procedure				
Headform Test	37.7	37.8	94.1	83.5
TRL Upper Legform Test	17.9	24.6	4.8	12.2
FlexPLI Test	44.4	37.6	1.0	4.3

Source: Mallory, A., Yarnell, B., Kender, A., & Stammen, J. (2019, May). Relative frequency of U.S. pedestrian injuries associated with risk measured in component-level pedestrian tests (Re-port No. DOT HS 812 658). Washington, DC: National Highway Traffic Safety Administration.

B. Vehicle Scoring and Verification Testing Example

In the hypothetical example of a verification test presented below, the vehicle is assumed to have met NHTSA's minimum requirements for pedestrian protection credit and verification testing. In other words, the manufacturer reported to NHTSA that its vehicle met the minimum requirements (*i.e.,* at least 60 percent or 21.600 out of 36.000 points); the manufacturer provided predicted and/or actual test data in a standardized format; NHTSA reviewed this data for accuracy and completeness; and NHTSA selected this vehicle for verification testing.

Figure 17 and Table 25 are examples of the format of head impact data a manufacturer would provide to NHTSA in order to receive credit for meeting

NHTSA's pedestrian protection criteria under NCAP. This figure shows the grid points along the various WAD lines eligible for testing based on vehicle geometry and the manufacturer's predicted color band for each location. Similar to the Euro NCAP test procedures, some points are considered ''default red'' and ''default green'' based on their location on the vehicle.[123] The rest of the eligible grid points are filled in with predicted HIC ranges from the manufacturer. Table 25 shows the tabulated data from Figure 17 and the manufacturer's predicted score (81.000 out of a possible 142.000) for the head. Figure 17 also denotes with an ''X'' which grid points were chosen for verification testing by NHTSA.

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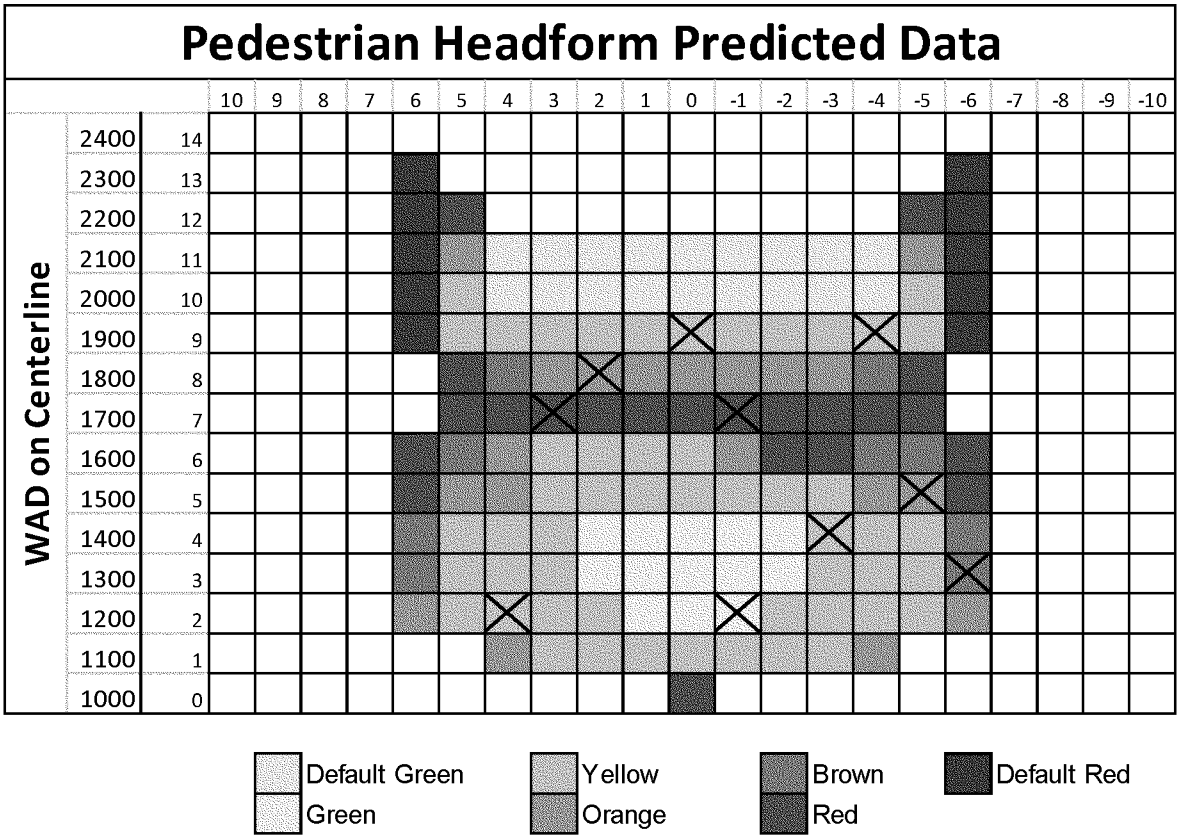

Figure 17: Example of Manufacturer's Predicted Head Impact Data

TABLE 25—EXAMPLE OF SCORING OF MANUFACTURER'S PREDICTED HEAD IMPACT DATA

Manufacturer prediction	HIC min.	HIC max.	Point value	Number points	Predicted score
Default green	n/a	n/a	1.000	18	18.000
Green	....	<650	1.000	13	13.000
Yellow	650	<1,000	0.750	51	38.250
Orange	1,000	<1,350	0.500	19	9.500
Brown	1,350	<1,700	0.250	9	2.250
Red	1,700	....	0.000	22	0.000
Default Red	n/a	n/a	0.000	10	0.000
Sum of all points excluding default points to be used for correction factor				114	63.000
Predicted headform score				142	81.000

Table 26 includes both the manufacturer's predicted scores for each grid point undergoing testing as well as the actual verification test result in the form of the HIC and resulting scoring band. In this example, 7 of the 10 test points resulted in the same scoring band as the prediction, 2 test points resulted in a lower scoring band than the prediction, and 1 test point resulted in a higher scoring band than the prediction. One test location of particular interest in this example is test location (4, −3). The resulting HIC at this test location was 1,046.87, outside

[123] Euro NCAP stipulates that test points located on the A-pillars are default red, and test points located in the central portion of the windshield glazing away from edges or underlying components are default green.

the boundaries for the predicted yellow color band, but still within the acceptable HIC range for verification testing as described in Table 15. The manufacturer predicted that the 10 test points under consideration would contribute a score of 5.250—as shown in Table 26. However, verification testing determined that these 10 test points scored 4.500 instead of 5.250. Thus, based on Equation 5, to determine a correction factor value (also shown below Table 26), the difference between the manufacturer's predicted values and those tested resulted in a correction factor of 0.857 (three significant digits).

Table 26: Example of Verification Testing Results and Correction Factor

VERIFICATION TESTING			
Test Point Location	Manufacturer Prediction	Test Value (HIC)	Tested Score
9,-4	0.75	1445.14	0.250
2,4	0.75	821.91	0.750
2,-1	1.00	612.55	1.000
9,0	0.75	829.58	0.750
4,-3	0.75	946.87	0.750
7,-1	0.00	3974.53	0.000
8,2	0.50	925.06	0.500
5,-5	0.50	2030.53	0.000
3,-6	0.25	1202.70	0.500
7,3	0.00	4810.86	0.000
Total	5.250		4.500
Correction factor		0.857	

Green Orange Red
Yellow Brown

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Table 27 calculates the resulting Final Pedestrian Headform Score for this hypothetical vehicle. The correction factor determined above is applied to all grid points that are not default green grid points. Thus, instead of those points contributing a predicted score of 63.000 points, they only contribute a score of 53.991 points. The 18 default green points still contribute a score of 18.000 (shown in Table 25 and Table 27), giving the vehicle a score of 71.991, or, when reduced for the 3⁄8, 3⁄8, 2⁄8 scoring allocation, a score of 6.844 out of 13.500 points.

TABLE 27—EXAMPLE OF HEADFORM SCORE WITH CORRECTION FACTOR APPLIED

114	Predicted (excluding Default Green)	63.000 × 0.857 = 53.991	
10	Default Red		0.000
18	Default Green		18.000
142	Total Grid Points	Vehicle Score	71.991
Maximum Pedestrian Headform Score (As shown in Table 9 or 3⁄8 allocation of 36 points)			13.500
Final Pedestrian Headform Score		71.991/142 * 13.500 = 6.844	

For the upper legform score, Table 29 below shows the upper legform verification testing results of the hypothetical vehicle. Due to vehicle geometry, a total of 13 points were eligible for testing, and it was decided that testing would be at test location U 0. Additional tests were conducted at locations U +2, U −4, and U −6. Utilizing symmetry and adjacency, all 13 test locations received scores.

Test locations were scored according to Table 11, and the scores are illustrated below as Table 28 for reference. Test location U 0 received a score of 0.000 because all the bending moments and the sum of forces exceeded the maximum injury limits. Test location U +2 also received a score of 0.000. Although some of the bending moments (upper and lower) were below the maximum injury limit, the upper legform test utilizes the worst performing injury metric for the test location's score. Both the center bending moment and the sum of forces exceeded the maximum injury limit, thus this test location received a score of 0.000. Had test location U +2 been scored based on the upper bending moment, it would have received a score of 0.475; and similarly, had it been scored based on the lower bending moment, it would have received as core of 0.356. Injury values above the minimum injury but below the maximum injury are scored on a sliding scale between 0.000 and 1.000 points for the upper legform. On the other hand, test locations U −4 and U −6 each received scores of 1.000 because all injury criteria were below the minimum injury limit.

TABLE 28—UPPER LEGFORM SCORING

Component	Min. injury	Max. injury	Max. point value
Bending Moment (Nm)	285	350	1.00
Sum of forces (N)	5,000	6,000	

Using symmetry, test location U −2 receives a score of 0.000 because that is what test location U +2 received. Test locations U +4 and U +6 receive scores of 1.000 because of tests conducted at U −4 and U −6. Using adjacency, test locations U +1, U −1, U +3, and U −3 all receive scores of 0.000 because they are adjacent to a test location that received a score of 0.000. Likewise, test locations U +5 and U −5 each receive a score of 1.000, being adjacent to two locations each scoring 1.000. In some cases, a manufacturer may provide data explaining why their vehicle should not be subject to symmetry or adjacency.

Table 30 shows the scoring for the hypothetical upper legform test. Overall, the vehicle received a score of 6.000 out of a possible 13.000 for the upper legform test. When scored against the 2⁄8 points allocation (out of 36 points), the upper legform can receive a maximum score of 9.000 points. This testing results in a final upper legform score of 4.154 out of 9.000 points.

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Table 29: Example of Upper Legform Test Results

Pedestrian Upper Legform		Bending Moment (Nm)						Forces (kN)				Total
		Upper		Center		Lower		Upper	Lower	Sum		
1st Point to Test: U 0		Value	Points	Value	Points	Value	Points	Value	Value	Value	Points	Points
U +6	Symmetry											1.000
U +5	Adjacent											1.000
U +4	Symmetry											1.000
U +3	Adjacent											0.000
U +2	Tested	319.15	**0.475**	374.28	**0.000**	326.87	**0.356**	2.83	2.86	5.66	**0.340**	0.000
U +1	Adjacent											0.000
U 0	Tested	376.95	**0.000**	459.15	**0.000**	417.88	**0.000**	3.01	3.48	6.49	**0.000**	0.000
U -1	Adjacent											0.000
U -2	Symmetry											0.000
U -3	Adjacent											0.000
U -4	Tested	147.83	**1.000**	160.73	**1.000**	147.22	**1.000**	1.86	3.25	4.82	**1.000**	1.000
U -5	Adjacent											1.000
U -6	Tested	165.33	**1.000**	200.61	**1.000**	186.05	**1.000**	1.51	2.58	4.09	**1.000**	1.000

Green
Yellow
Orange
Brown
Red

Table 30: Example of Upper Legform Score

Test Location	U+6	U+5	U+4	U+3	U+2	U+1	U0	U-1	U-2	U-3	U-4	U-5	U-6
Points	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000
Total Number of Test Points				13									
Total Vehicle Score				6.000									
Maximum Pedestrian Upper Legform Score (2/8 of 36 points - shown in Table 9)				9.000									
FINAL PEDESTRIAN UPPER LEGFORM SCORE				**(6.000 / 13) * 9.000 = 4.154**									

Green
Yellow
Orange
Brown
Red

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Finally, Table 32 below shows the lower legform FlexPLI verification testing results of the hypothetical vehicle. Like the upper legform WAD775 tests, this vehicle's geometry requires 13 locations to be tested for the bumper testing. In this test series, testing began at location L +1 and additional tests were carried out at locations L –3 and L –5.

Test locations were scored according to Table 12 as illustrated below in Table 31 for reference. Testing conducted at location L +1 yielded a score of 0.932 (0.500 + 0.432). The tibia bending moments were all below the minimum injury limit, awarding full points for that component. The MCL elongation fell in between the minimum injury limit and maximum injury limit, awarding partial points. For FlexPLI injury values above the minimum injury threshold and below the maximum injury threshold, points are awarded between 0.000 and 0.500 on a linear sliding scale. Neither the ACL nor PCL exceeded the limit. Thus, this test location received a score of 0.932. Tests conducted at locations L − 3 and L –5 yielded full points as none of the values exceeded the minimum injury limits, nor were the ACL nor PCL limits exceeded.

TABLE 31—FLEXPLI SCORING

Component	Min. injury	Max. injury	Max. point value
Tibia bending (Nm)	282	340	0.50
MCL elongation (mm)	19	22	0.50
ACL/PCL elongation (mm)		10	0.00

Using the same symmetry concepts discussed above, test locations L − 1, L +3, and L +5 inherited the scores from the opposite side. Using adjacency, test locations U 0, U +2, and U − 2 each inherited a score of 0.932 because that was the lowest score of the two adjacent test locations. Test locations L +4, L − 4, L +6 and L − 6 each inherited a perfect score of 1.000 because both adjacent test locations had scores of 1.000.

The resulting lower legform score for this vehicle is shown below in Table 33 and was 12.660 out of a maximum 13.000, or 13.147 out of a maximum 13.500 when using the 3⁄8, 3⁄8, 2⁄8 scoring allocation.

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Table 32: Example of Lower Legform Test Results

Pedestrian Lower Legform		Tibia Bending Moment (Nm)					ACL/PCL (mm)			MCL Elongation (mm)		Total
		T1	T2	T3	T4	Points	ACL	PCL	PASS/ FAIL			
1st Point to Test: L +1		Value					Value			Value	Points	Points
L +6	Adjacent											1.000
L +5	Symmetry											1.000
L +4	Adjacent											1.000
L +3	Symmetry											1.000
L +2	Adjacent											0.932
L +1	Tested	210.37	168.77	127.35	68.42	**0.500**	5.66	5.38	**PASS**	19.41	**0.432**	0.932
L 0	Adjacent											0.932
L -1	Symmetry											0.932
L -2	Adjacent											0.932
L -3	Tested	166.44	153.62	153.23	77.63	**0.500**	4.39	2.97	**PASS**	12.22	**0.500**	1.000
L -4	Adjacent											1.000
L -5	Tested	114.34	137.06	113.75	65.64	**0.500**	2.78	5.56	**PASS**	10.47	**0.500**	1.000
L -6	Adjacent											1.000

Green Yellow Orange Brown Red

Table 33: Example of Lower Legform Score

Test Location	L+6	L+5	L+4	L+3	L+2	L+1	L 0	L-1	L-2	L-3	L-4	L-5	L-6
Points	1.000	1.000	1.000	1.000	0.932	0.932	0.932	0.932	0.932	1.000	1.000	1.000	1.000
Total Number of Test Points	13												
Total Vehicle Score	12.660												
Maximum Pedestrian Lower Legform Score (3/8 of 36 points - shown in Table 9)	13.500												
FINAL PEDESTRIAN LOWER LEGFORM SCORE	**(12.660 / 13) * 13.5000 = 13.147**												

Green
Yellow
Orange
Brown
Red

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In Table 34 below, the scores from the 3 component tests are summed together and compared to the maximum available score. In this scenario, the hypothetical vehicle had reduced component level scores in each of the three categories, but still maintained a total score above 21.6 (60 percent). Therefore, this vehicle would continue to receive pedestrian protection credit on *http://www.NHTSA.gov.*

TABLE 34—EXAMPLE OF OVERALL PEDESTRIAN PROTECTION SCORE

	Actual score	Maximum score	Percentage
Headform Test	6.844	13.500	50.7
Upper Legform Test	4.154	9.000	46.2
Lower Legform Test	13.147	13.500	97.4
Total	24.145	36.000	67.1
Received Pedestrian Protection Credit?			Yes.

C. Questions Asked Throughout This Notice

[1] NHTSA seeks comment on the topic of female leg safety. Are there data showing that vehicle front end designs that perform well in the FlexPLI and upper legform impact tests would not afford protection to female pedestrians? Are there any legforms representing female or small stature pedestrians? Are there female specific data and associated 5th percentile female specific injury criteria for use with a 5th percentile female legform impactor?

[2] NHTSA seeks comment on what an acceptable humidity tolerance should be for the qualification tests of the upper legform impactor and the associated vehicle test with the upper legform.

[3] NHTSA is requesting comment on the FlexPLI qualification procedures—specifically which procedures (dynamic and quasi-static) should be used for qualification, and how often they should be conducted?

[4] An Agency study of Abbreviated Injury Scale (AIS) 3+ pedestrian injuries in the U.S. showed that the apportionment of points in NCAP for crashworthiness pedestrian protection should be ⅜th for head impact test results (37.5 percent), ⅜th for lower leg impact test results (37.5 percent), and 2⁄8th for upper leg impact test (25 percent). NHTSA seeks comment on whether injury severity or frequency would be this the most appropriate basis for point allocation apportionment.

[5] As concluded in the Agency's FlexPLI research report, NHTSA believes the FlexPLI legform is biofidelic and seeks comment from the public on whether biofidelity concerns with the FlexPLI still remain at this time.

[6] NHTSA is seeking comment on what procedure it should use for marking the test zone on bumpers. In other words, should the procedure harmonize with the Euro NCAP 60-degree angle method or should it follow the GTR 9 and UNECE R127 corner gauge method?

[7] GM suggested that if a vehicle has an exposed bumper, the bumper test zone should use the 60-degree angle method instead of testing the full bumper width to eliminate testing at the extreme edge of what may be a curved bumper. NHTSA requests comment on this concern as well, as it is similar to the previous question for bumper test zones.

[8] Given the pedestrian death and injury crisis on U.S. roadways NHTSA is seeking comment on test speeds. Should test speeds for either of the head or leg tests be increased in an attempt to provide better protection to pedestrians in vehicle to pedestrian crashes? Should the area of assessment be increased beyond the WAD 2100 mm currently proposed to account for pedestrian heads overshooting the hood and impacting the windshield or the roof of the vehicle?

[9] NHTSA requests comment on the seven Euro NCAP documents proposed in section IV. F. (Euro NCAP Pedestrian Testing Protocol Version 8.5, Euro NCAP Assessment Protocol—Vulnerable Road User Protection Part 1—Pedestrian Impact Assessment Version 10.0.3, Euro NCAP Pedestrian Headform Point Selection V2.1, Euro NCAP Film and Photo Protocol Chapter 8—Pedestrian Subsystem Tests V1.3, Euro NCAP Technical Bulletin TB 008 Windscreen Replacement for Pedestrian Testing Version 1.0, Euro NCAP Technical Bulletin TB 019 Headform to Bonnet Leading Edge Tests Version 1.0, and Euro NCAP Technical Bulletin TB 024 Pedestrian Human Model Certification V2.0)—do any elements of these documents need modification for the U.S. NCAP?

[10] NHTSA requests comment on TB 024 and its relevance to the U.S. NCAP. Should the models and methods in TB 024 or some other method be used to calculate head impact times to evaluate vehicles with active hoods?

[11] NHTSA seeks comment on what level of detail should be required for self-reported data. Should manufacturers be allowed to submit predicted head and leg response data, or only actual physical test results? Should reporting consist of just the results for each test location, or should full data traces or a comprehensive test report including photographs and videos be required?

[12] NHTSA requests comment on whether vehicles with an LBRL greater than 500 mm should be eligible to receive crashworthiness pedestrian protection credit because they will automatically receive a zero score for the FlexPLI bumper tests.

[13] NHTSA requests comment on the proposal to reposition the upper legform ±50 mm from the WAD775 target when artificial interference is present or to conduct multiple impacts within ±50 mm from the WAD775 target and use the worst-case result when artificial interference is present.

[14] NHTSA tentatively plans to use the corner gauge and bumper beam width procedure for corner definition for this NCAP proposal and requests comment on this change.

[15] NHTSA seeks comments on whether there is benefit in requiring both the Pendulum and Inverse Impact dynamic qualification tests in addition to the quasi-static tests. Also, what should the qualification test schedule be for the FlexPLI be?

[16] NHTSA seeks comment on what the required detection area should be for vehicles with active hoods. Additionally, which device should be used for assuring the system activates properly, the Flex-PLI or the PDI2?

[17] NHTSA proposes utilizing a modified ⅜, ⅜, 2⁄8 scoring apportionment for the head impacts, Flex PLI impacts, and upper leg impacts

respectively for NCAP and requests comment on this proposal.

[18] NHTSA seeks comment on whether [a checkmark on *NHTSA.gov*] is an appropriate way to identify vehicles that meet the Agency's minimum criteria for crashworthiness pedestrian protection, or if some other notation or identifying means is more appropriate.

[19] NHTSA seeks comment on what options or features might exist within the same vehicle model that would affect the vehicle's performance of crashworthiness pedestrian protection. NHTSA also seeks comment on whether the Agency should assign credit to vehicles based on the worst-performing configuration for a specific vehicle model, or if vehicle models with optional equipment that affect the crashworthiness pedestrian protection credit should be noted as such.

[20] NHTSA seeks comment on the proposal to conduct verification testing as part of the crashworthiness pedestrian protection program by adjusting the head score using a conversion factor determined from laboratory tests and replacing manufacturer supplied FlexPLI and upper leg scores with NHTSA scores from laboratory tests.

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Sophie Shulman,

Deputy Administrator.

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