ALLIANCE FOR AUTOMOTIVE INNOVATION

September 16, 2024

Ms. Sophie Shulman
Acting Administrator
National Highway Traffic Safety Administration
1200 New Jersey Avenue, S.E.
Washington, D.C. 20590

RE: Advance notice of proposed rulemaking (ANPRM) on Federal Motor Vehicle Safety Standards; Seating Systems [Docket No. NHTSA-2024-0001]

Dear Acting Administrator Shulman,

The Alliance for Automotive Innovation (Auto Innovators) appreciates the opportunity to provide comments in response to the July 16, 2024, Advance Notice of Proposed Rulemaking (ANPRM) to update Federal Motor Vehicle Safety Standard (FMVSS) No. 207 "Seating Systems."[1,2] Our members are committed to ensuring that vehicle occupants are protected in order to reduce serious injuries and fatalities. The automotive industry has been proactive in efforts to improve rear-impact safety through significant investments that not only enhance occupant protection in the event of a rear-end collision, but also to help reduce the occurrence and severity of crashes occurring in the first place.

Auto Innovators supports NHTSA efforts to update the existing standards for evaluating seat back strength in rear impact collisions. Since FMVSS No. 207 was first established, manufacturers have made continued progress in advancing state-of-the-art seat designs, with modern seating systems far exceeding the level of performance required by the current standard. Auto Innovators also supports the agency's approach to updating both FMVSS No. 202a and FMVSS No. 207 as part of a combined rulemaking effort. Whether the agency decides to integrate the two standards into a single FMVSS is secondary to the actual structure and content of the requirements that the agency seeks to establish.

In general, developing rear impact performance for seating systems is most effectively accomplished through balancing occupant performance requirements for both the more frequent, but less severe, lower speed rear impacts with less frequent, but more severe, higher speed impacts. The wide range of occupants' heights and weights should also be considered. Velocity targets and test devices for both cases need to be carefully defined based on field data research and the availability of well-developed Anthropomorphic Test Devices (ATDs). We also recommend, as discussed in more detail below, that the FMVSS should also focus on dynamic sled testing, using the BioRID ATD for low-speed testing, and Hybrid III 50th percentile male (HIII-50M) ATD for high-speed testing.

---

[1] Auto Innovators represents the full auto industry, including the manufacturers producing most vehicles sold in the U.S., equipment suppliers, battery producers, semiconductor makers, technology companies, and autonomous vehicle developers. Our mission is to work with policymakers to realize a cleaner, safer, and smarter transportation future and to maintain U.S. competitiveness in cutting-edge automotive technology. Representing approximately 5 percent of the country's GDP, responsible for supporting nearly 10 million jobs, and driving $1 trillion in annual economic activity, the automotive industry is the nation's largest manufacturing sector.
[2] 89 FR 57998

That said, further research and analysis is needed to better define the scope and objectives of this rulemaking effort, and to ensure appropriate balance with respect to the overall regulatory impact and anticipated safety benefits brought about by the current requirements. We also recommend additional research to further evaluate the characteristics and performance of contemporary seat designs when making determinations for how future standards should be set, as much of the existing literature covers legacy vehicle designs.

General Summary

The following section summarizes our general positions on key topics included in the ANPRM. These are discussed in more detail in the sections that follow, below.

- **Further research is needed.** Underlying all our comments is the fact that more research is needed before rulemaking proceeds. Given the importance of ensuring a robust rulemaking that carefully balances the potential for unintended consequences, there are several key areas that require further study. These include an evaluation of occupant injury mechanisms in relatively rare, higher speed rear-end crashes in which serious-to-fatal injuries occur compared with more frequent lower speed collisions in which majority of reported minor injuries accounting for disproportionate societal harm occur. Regulations require repeatable, reproducible test procedures, test devices and relevant acceptance criteria based on established correlation with real-world injury data. We encourage the agency to publish the findings of its research. This practice will provide the safety community with an opportunity to review and provide comments. Facilitating a more engaged, transparent process will help ensure a more robust, data-driven rulemaking.

- **Dynamic sled testing for both low and high speed evaluations**. Here, we suggest prioritizing dynamic testing over static testing. When evaluating occupant interaction with the seat, we expect dynamic testing may more effectively produce conditions representative of those experienced by seating systems in real-world crashes. By comparison, alterations to the seat and head restraint standards that focus on static tests may result in seat evaluations and results that may require design changes that may not improve safety. Recognizing also that dynamic tests may not be able to evaluate all aspects of seat performance, we suggest that NHTSA maintain the dimensional and static performance evaluations from FMVSS 202a, to evaluate head restraint stiffness. NHTSA should also consider harmonizing future requirements with the UNECE R17 Rev. 11 / GTR 7 criteria and methodology to support greater homologation in seat design.

- **BioRID ATD for low-speed evaluations.** The primary use for this ATD is to evaluate interaction with the head restraint at low speeds in planar impacts in the mid-sagittal plane of the ATD, not the seat structure. However, it is not robust in high-speed testing. For low speed, IIHS is expected to continue using the BioRID ATD for an anticipated 24 km/h test in their upcoming protocol. It is important to ensure that any injury assessment reference values and associated injury metrics are appropriately set, as the current requirements have a low correlation with claim frequencies. The FMVSS 202a has head restraint geometric and strength requirement or a low velocity dynamic test. The correlation of FMVSS No. 202a with insurance claim frequencies is not known and a study might help.

- **HIII-50M for evaluating kinematics and seat response in high speed collisions.** For high speed, the Hybrid III 50th percentile ATD set-up for rear impact has been demonstrated as an accurate

and reliable tool.[3,4] Similar to the comment above, it is important that the injury risk criteria correlate with real world injury risk.

1 Comments on NHTSA Data Analysis

Auto Innovators agrees with the agency's conclusion that data is limited and that the occurrence of serious injuries are relatively limited when compared to other crash modes. Based on an initial review of the research provided in the ANPRM, we recommend further study to investigate occupant injury risk based on seating position and rear impact severity, as this was notably absent from the analysis. The data provided in the notice also does not definitively explain the safety concern based on crashes involving modern seat designs and these analyses should be updated to include crashes involving more recent model year vehicles.

It is important to note however, that while severe crashes are rare and associated with a high delta-V, the overall percentage of whiplash injuries may be overrepresented in rear impacts compared to the overall number of tow-away rear impacts.[5] Most of the reported rear impact soft tissue neck injuries occur at a low Delta-V in which the vehicles are not towed-away, and as a result, this may not be captured in the existing NHTSA databases. Additionally, these soft tissue neck injuries may not be accurately coded in all cases because they are a self-reported injury without a clear medical diagnosis or basis. The agency should consider how potential differences in real-world reporting may need to be accounted for as part of its preliminary regulatory impact analysis, as simply changing to a higher speed may not affect responses at lower speeds.

2 General Comments on NHTSA Response to Petitions for Rulemaking

NHTSA seeks comments on its assessment that the research provided in the Saczalski and Cantor petitions is insufficient to demonstrate a worsening safety need or to support the proposed strength levels or test designs. In general, we agree with this conclusion. However, the current lack of publicly available data and research indicates that further analysis is needed to inform the rulemaking process and how specific strength levels and test conditions should be set, as specifying strength levels alone does not fully consider injury mechanisms at high or low speeds. If relevant performance metrics can be evaluated through dynamic testing, static testing may not be necessary – particularly as the correlation between peak strength and injury outcomes are low.[6]

Rear Seat Intrusion

NHTSA seeks comment on the significance of rear row intrusion and whether there is a practicable solution to address this issue. To address this question, we recommend the agency conduct an in-depth study on the safety risk to children in rear seat rear impacts in modern vehicles in which intrusions in the rear end of vehicles were reduced for compliance with the FMVSS No. 301 rear impact test. This would be beneficial for informing the agency's decision on this aspect of performance, as there are several variables that could potentially affect injury outcomes for rear row occupants in this crash mode. To

---

[3] Prasad P, Kim A, Weerappuli DPV. 1997. Biofidelity of anthropomorphic test devices for rear impact. SAE 973342. 41st Stapp Car Crash Conference, Society of Automotive Engineers, Warrendale, PA, doi:10.4271/973342

[4] Viano DC, Parenteau CS, Burnett R, Prasad P. 2018. Occupant responses in conventional and ABTS seats in high-speed rear sled tests with a normally seated dummy. Traffic Inj. Prev. 19(1):54–59. 2 doi:10.1080/15389588.2017.1347782

[5] The inclusion of cases in NASS or CISS requires that at least one involved vehicle be towed from the scene.

[6] Padmanaban et al. Seat back strength as a predictor of serious injury risk to belted drivers and rear seat occupants in rear crashes, SAE 2016-01-1512

avoid unnecessary delays in the rulemaking process, we recommend this include a comprehensive review of published literature as a basis for identifying areas that require further analysis.[7]

In higher speed impacts, further research is needed to describe the correlation between dummy criteria and seat stiffness across all dummy percentiles. If the strength of the rear of the vehicle is increased and the intrusion of structures is reduced during a rear impact collision, the acceleration applied to the vehicle body will increase, which may increase the risk of other injuries. It is therefore important to strike a balance when it comes to passive systems. The agency should also evaluate the extent to which fixed seat rotation requirements should be included in FMVSS.

Safety Considerations Seat Stiffness

Auto Innovators agrees with NHTSA on the importance of considering the overall safety problem in occupant protection in rear impacts. Vehicle manufacturers have extensive experience in the design of seating systems that provide increased protection for both front and rear row occupants beyond the current FMVSS. NHTSA must carefully consider the potential unintended consequences if the rule is not appropriately balanced with consideration for both low and high severity crash conditions in modern seats. For example, increasing the seat back strength to address high-speed impacts may conflict with design countermeasures to mitigate the potential for soft tissue neck injuries in low-speed crashes. Conversely, in high-speed conditions, there are limitations in terms of how the seat may be expected to support energy absorption without increasing the risk of injury.

The data provided by NHTSA indicates the relatively high occurrence rate of low-speed impacts compared to those at higher speeds. However, there is a clear understanding that the seat structure must be balanced to achieve both low-speed and high-speed performance targets for occupant injury – the lower the stiffness of the seat, the lower the level of acceleration experienced by the dummy, which would in turn help address injury severity. Ultimately, NHTSA needs to more clearly define how it intends to balance these competing needs as part of any FMVSS 202a and FMVSS No. 207 update. For instance, a rule that focuses exclusively on fatality reduction is likely to lead to seat designs that are different than if the intent is to balance low-speed and high-speed injuries. Such a theoretical rule also may pose additional risks to, for example, out of position occupants, smaller occupants, and occupants with compromising medical issues. With respect to the development of regulatory test procedures for evaluating seat back performance, it is important that velocity targets and occupant sizes for both cases need to be carefully defined based on field data research and the availability of well-developed ATDs. We also recommend the referenced study be updated as the data is not representative of modern seat designs.

2.1 Comments on Matters which NHTSA is Granting and Denying the Petitions

NHTSA is seeking comments on various matters related to the petitions it has granted. These are discussed in more detail below.

Amend FMVSS No. 207 To Increase Seat Back Moment Requirement and Alter Load Application Method.

As noted in the ANPRM, "NHTSA is granting the [Saczalski] petition on the torque requirement and static test design issues in part, is initiating rulemaking to consider whether to upgrade FMVSS No. 207 on these topics" and seeks comment on upgrading FMVSS.

---

[7] *David C. Viano (2023): Safety priorities for occupant protection in rear impacts, Traffic Injury Prevention, DOI: 10.1080/15389588.2023.2171177*

In general, Auto Innovators is supportive of an increase to the seat back moment requirements to align more closely with contemporary seating systems. While static pull testing could have some benefits for evaluating structural integrity of seats and provide good reproducibility, there are also limitations in using these types of tests to reliably assess certain injury mechanisms or the elasticity of the seat cushion and seat structure. Depending on the objective of the regulation, a dynamic test may provide a more representative means to assess required seat back stiffness. From a harmonization perspective, dynamic testing would also more closely align with other international programs that have shifted more toward this type of approach.[8]

However, if a static test is proposed, we recommend the agency consider load application using a 95th percentile male body block, similar to the FMVSS No. 202a backset retention test. A comparison of several quasi-static body block testing is reported by Burnett et al.[9] This study showed that responses of the seat structure can be different in the different test procedures. Much more testing and research is required to choose the best static test procedure. The use of a metal bar to apply loads at the top of the seat back in upwards of 2260Nm could result in unrealistic deformation in the seat structure, particularly in the upper cross member and seat back side members.

We disagree with the proposal to increase the seatback moment load by a factor of six (6) without supporting data. The 2260 Nm requirement is 3.1 times higher than the FMVSS No. 202a requirement of 654 Nm (5788 inch-pounds), and we oppose the risk of inconsistency in requirements by arbitrarily increasing the seat back strength. It is not reasonable to propose specific test methods and load values without robust data analysis to ensure the agency is not introducing any unintended consequences as a result of changes in the FMVSS.

In addition, the agency should also minimize test burden where possible. For example, to the extent that dynamic testing is demonstrated to be objective, repeatable, reproducible, and capable of measuring comparable aspects of performance to static testing, and vice versa, there should not be a need for duplicative or potentially conflicting test procedures.

Drop in load requirements

We do not agree with the agency's assessment that a drop in load indicates an unsafe design. Seating systems typically include design elements built with the intent to absorb high energy loads in dynamic events, and twisting of the back rest may be expected. When tested statically, the deformation is not linear. Therefore, drops in load may occur, and in some cases may be an intended design response. In place of a requirement to measure for drop in load, we propose the agency consider a requirement for no loss of a locking position based on a defined deflection criteria. If a load drop of 1780N (400lb-f) or more is required within a short span, additional supporting data must be provided to justify the proposal beyond the analysis provided in the ANPRM and related petition. The research should also inform other test parameters, including test load reach time, load holding time, ATD seating position.

Structural Symmetry

While we recognize the implementation of a dynamic rearward deflection requirements may better represent the kinematics associated with certain crash conditions, there is insufficient data to support setting specific test criteria. Furthermore, the adoption of dual-sided recliners across the industry makes this requirement less relevant, and there is limited benefit in structural symmetry when the restricted

[8] *i.e., EuroNCAP, UNECE R17 Rev. 11.*

[9] *Burnett et al., Quasi-static methods to evaluate seat strength in rear impacts, Traffic Injury Prevention, Oct., 2022*

angle of rearward rotation is so small. Dual recliners enable forces and energy to be managed equivalently on either side of the occupant, and establishing anti-twisting requirements may inhibit the need for controlled deformations that manage stress/strain and energy (i.e., the proposed 15-degree angle may be too small and may result in a stiff seatback structure). Asymmetrical deformation can also be affected by vehicle architecture and impact direction, and there are other common components, besides the recliner, within the seat structure that also have a significant impact on symmetrical seatback rotation. For example, the section capacity of the seat cushion frame side members has a significant effect on seatback rotation and "twisting" mechanism. In short, inclusion of dual recliners does not guarantee decrease of seatback twisting. We therefore oppose the agency's proposal to include such a requirement in FMVSS.

If NHTSA seeks to prescribe a limit to seatback twisting, it should be based on a real-world reduction in measurable injury risk as opposed to simply establishing a prescriptive hardware design. Seats that are too stiff may result in additional injuries to the occupant in the seat being tested while trying to protect the occupant in the seat behind it. Furthermore, the rear seating position being protected from front seat deflection has a much lower occupancy rate, potentially adding more overall risk to the occupants in the vehicle. We suggest that NHTSA provide a generic crash pulse so that any deflection criteria values can be standardized as a fixed maximum value. We also suggest that more research is required to determine what a proper maximum deflection criteria would be that balances the protections for both the front and rear occupants. It is also necessary to ensure that the test procedure is representative of real world conditions.

Dynamic Rear Impact Test Design

Auto Innovators is opposed to the proposal to require a new dynamic full vehicle barrier test in FMVSS No. 207. We recommend that the agency instead consider a dynamic sled test as this is sufficient and more practicable for evaluating seat performance when exposed to rear-impact conditions. A seating system's high speed rear impact performance is most effectively evaluated with a rear impact sled test focused on occupant performance, as opposed to a full-scale vehicle test.

The conditions of any dynamic test ultimately need to be determined based on real-world data to identify the risk of injury. The generic acceleration pulse for this test should be derived from a vehicle-to-vehicle barrier test which creates a typical double peak rear impact shape. NHTSA should also consider providing a compliance option to allow manufacturers to use the vehicle pulse if it is lower than the generic pulse.

A component-level sled-based approach also provides manufacturers with the ability to develop seating systems across vehicle lines, as the same seat structure is sometimes used across different make and model vehicles. When standardized sled tests with repeatable parameters are conducted, the data can be compared across multiple programs. From a repeatability and reproducibility perspective, vehicle-level barrier tests also introduce new variables unrelated to seat back performance, such as intrusion, body stiffness, the effects of different vehicle masses, and more. This further limits the ability to compare test-to-test data and improve seats across vehicles. Full vehicle tests also limit the ability to evaluate and improve seat designs early in vehicle development before prototype vehicles are available.

Additional Questions on the Saczalski Petition

In general, we agree with NHTSA's assessment that it is not suitable to base its selection of test parameters on two data points, and unfortunately, we are unable to provide any additional data on a proposed test design.

With respect to the agency's request for comment on the biofidelity limitations of HIII ATDs when used for rear impact analysis, Auto Innovators supports the agency's inquiry on this matter.

We recommend the use of BioRID for low speed impact and the HIII-50M ATDs for high speed testing. It is important however that this ATD is incorporated in Part 572 prior to use in FMVSS. Further study should also be conducted to determine appropriate injury assessment reference values prior to any NPRM, as well as to evaluate the potential for any unintended consequences, including any repeatability and reproducibility concerns. We also note that the HIII-95M ATD has not been fully developed for rear impact testing and would require a substantial effort to incorporate in Part 572.

We also agree with NHTSA denying the petitions to amend FMVSS No. 209 and FMVSS No. 213.

3 Recommendations on the Development of a NPRM

NHTSA is seeking comment broadly on an update to the FMVSS regarding occupant protection in moderate and severe rear impacts. However, as discussed previously, and in more detail below, without additional in-depth analysis on specific injury mechanisms, it is not possible to provide definitive recommendations on how the agency should establish its evaluation criteria and test conditions. It is important that the process is data driven with consideration for the potential injury risks in both low and high speed rear impact crashes for both front and rear row occupants, and that FMVSS does not result in unintended consequences for occupants in other crash modes and have an adverse impact on modern seat designs.

3.1 Seat Back Strength and Other Mechanical Properties

Auto Innovators agrees with NHTSA on the challenges in developing a robust test procedure given that there are differences in the frequency and severity of impact conditions that different size occupants may be exposed to in real-world crashes. We again underscore the need for and importance of updated field data and analysis to inform the agency's decision on the potential assessment methods that are most appropriate for inclusion in FMVSS.

NHTSA should consider evaluating an approach that incorporates either static testing with a body block (*consistent with UNECE R17 (Rev. 11) and SAE J826*), dynamic low speed sled testing (*consistent with either Euro NCAP using BioRID with two crash pulses at medium and high pulse*), or UNECE R17 Rev. 11 (*with BioRID*) combined with high-speed sled testing. We suggest NHTSA also consider a generic pulse that would be defined by FMVSS No. 207, which is representative of the crash energy of most vehicles, and therefore allow for a seat back deflection requirement to be better defined for all vehicles and seat types. This is a similar approach to how FMVSS No. 202a dynamic testing is performed.

The agency should also conduct an analysis to identify whether reasonable limits of allowable deformation can be established, and whether establishing criteria based on a fixed rotation angle may provide a more robust means of evaluation when compared to testing with a HIII-3-year-old ATD in a rear facing child restraint.

3.2 Energy Absorption

NHTSA seeks comment on whether seat back energy absorption or force deflection and deformation should be regulated under FMVSS No. 207, and if so, what the appropriate performance levels should be. Although energy absorbing structures may help address the potential for front seat occupant injuries

under certain crash conditions, there are several factors that must be carefully considered, particularly at higher speeds. This includes research to understand the risk of injury due to rebound after initial seat deformation (which may affect repeatability and reproducibility), and the extent to which additional deformation could increase the risk to those in rear seats. Given that there may be no definitive level of performance it may not be possible to establish reasonable or easily measurable requirements in FMVSS.

3.3 Seatback Twisting/Rotation

We agree with NHTSA that further research is needed to evaluate the real-world injury risks associated with contemporary seat back designs and the extent to which it may or may not be possible to reasonably define objective, measurable criteria for evaluating performance under real-world impact conditions. With respect to dual recliners, there is limited utility in assessing structural symmetry when the restricted angle of rearward rotation is so small. Furthermore, measuring the change in angle of the left and right seatback frames and the displacement of dummy parts in dynamic tests requires video analysis, but accurate measurement and calculation is difficult using this approach and it may introduce a degree of subjectivity or increased potential for error in how the data is captured and analyzed.

3.4 Occupant Ramping (General)

We disagree with the agency on the need to regulate seat characteristics such as pocketing or the coefficient of friction of the upholstery. The intent of this rulemaking should be to establish objective criteria for evaluating the performance of the seating system, not its overall design and construction. Even if the agency were to seek to define certain characteristics, such as friction, the clothing worn by occupants will change the effective friction between the occupant and the seat back. Ramping is a dynamic phenomenon and is best measured in dynamic testing and a higher-speed rear impact sled test. Such a requirement is not needed if injury criteria are met.

3.5 Test Parameters

General

Auto Innovators agrees that two testing speeds are appropriate for assessing seatback performance in low- and high-speed conditions. However, as noted previously, it is not necessary to have multiple tests at each speed range for both FMVSS No. 202a and FMVSS No. 207. We propose that FMVSS No. 202a maintain a low-speed option, with FMVSS No. 207 adding a higher speed option. Auto Innovators' recommendations on how these specific requirements should be considered is discussed in more detail in other sections of this comment.

Quasi-Static Testing

NHTSA seeks comment on the use of quasi-static testing to help inform the development of objective measures, tests, and strength requirements for seat backs. While the current FMVSS No. 207 static loading method provides reproducible results, it is questionable whether there is a continued need for this type of evaluation as part of any updated requirements.

The deformation modes observed in this type of testing do not necessarily match the deformation observed in dynamic testing, and a dynamic testing approach is more representative of real-world conditions. Performing the static test at 2260Nm loads may result in seat failures that are not observed in the field, and as a result, could result in seat designs that do not address real world dynamic crash events. Our proposal is to remove the rearward moment test from FMVSS No. 207 and replace it with the dynamic sled test run on a rigid seat attachment fixture.

However, if a static option is chosen, research is needed to develop consensus on test device, test procedure, and acceptance criteria. As part of this analysis, we recommend NHTSA consider loads being applied through a body block similar to the FMVSS No. 202a backset/retention test body block over the use of a metal bar that applies the load at the top of the seat back. The direction of the load should be centered on the HP and follow the deformation of the seat back.

With respect to potential changes that can be made to the test method and standard for head-restraints from a quasi-static requirement perspective, we recommend that NHTSA consider harmonizing the requirements of FMVSS No. 202a with the UNECE R17 Rev.11 and GTR No. 7 head restraint technical requirements.

UNECE R17 rev.11 includes new height requirements and an updated measurement procedure. This measurement procedure determines the "effective top of the head restraint" to be in a position where the head restraint is "effective" at, rather than a measurement tangent to the top of the head restraint when measured normal to the torso angle. This method simplifies the test procedure and is also used by Euro NCAP. It eliminates inconsequential head restraint measurement variability resulting from minor shifts in H-point, and overall, the acceptance criteria for the dimensional requirements are more stringent than FMVSS No. 202a.

Dynamic Testing (General)

In general, we support the use of a high speed and low speed rear impact test with the rearward moment test eliminated from the FMVSS No. 207 specification. More specifically, and as discussed in more detail below, we propose the agency choose a generic crash pulse representative of a majority of vehicles at a typical rear impact crash speed. This generic crash pulse could be developed by utilizing current vehicle crash pulses at a similar speed as seen in the FMVSS No. 301 and FMVSS No. 305 rear impact integrity test.

4 Consideration of Anthropomorphic Test Devices (ATDs) and Test Speeds

NHTSA seeks comment on ATDs that would be most appropriate to use in both low and high-speed rear impact testing of seats, and whether using two different sized ATDs (for example, BioRID and BioRID-P50F) in one or both of these test configurations would offer a more comprehensive assessment of seat performance. In general, such a decision must be data driven and based on the objective and purpose of the test, and include an assessment of whether existing or new ATDs are needed to evaluate vehicle performance. It must also provide a correlation between expected injury risk or occupant response, ensure repeatability and reproducibility, and include clear methods for testing and calibrating the dummy. To the extent new dummies are required, this may delay rulemaking, and it may be necessary for NHTSA to instead redefine the scope of the rulemaking, as opposed to using a dummy that is not suitable for evaluating certain aspects of seat back performance in rear impact.

With respect to the referenced ATDs in the ANPRM:

- **BioRID** – The primary use for this ATD is to evaluate interaction with the head rest and not the seat structure. However, it is too sensitive for high-speed testing. Furthermore, we are not aware of testing that has been conducted in high-speed collision ranges, so repeatability and reproducibility is unknown. For low speed, IIHS is expected to continue using the BioRID for an anticipated 24 km/h test in their upcoming protocol.

- **HIII-50M** -- The HIII-50M ATD set-up for rear impact has been evaluated for use at speeds that represent high-speed rear impacts in the field.[10,11] Research has also established Injury Assessment Reference Values (IARVs) for rear impact. Setting up the ATD for rear impact includes using the lower neck load cell (with transfer function to calculate the moment at the base of the neck).[12] We do not, however, support the use of the HIII-95M as this ATD is not regulated by Part 572. Near-term efforts to incorporate the dummy will add further delay in finalizing the FMVSS No. 207 rulemaking.

- **BioRID-P50F & EvaRID** – Neither the BioRID-P50F nor EvaRID are sufficiently mature enough for inclusion in Part 572 or FMVSS at this time.

Differences in the ATDs selected for use in regulation will have varying outcomes when conducting the rear impact safety assessment. Comprehensive research is needed to determine if limiting seatback deformation in high-speed impacts would reduce fatalities and the extent to which changes in the requirements may have an adverse effect on other crash modes.

4.1 Low Speed Test

NHTSA seeks comment on various questions to inform the development of a potential low-speed test.

Use of the HIII-50M ATD

Auto Innovators supports the agency's consideration of alternatives to the HIII-50M ATD in low speed testing. We recommend that the agency consider adoption of the BioRID ATD consistent with the requirement of UNECE R17 (Rev. 11) and GTR No. 7. The ATD is also used by Euro NCAP and IIHS, enabling a more harmonized and integrated approach to seat back design. Any injury criteria should show correlation with the field data. More research into soft tissue neck injury as it applies to injury criteria for the low-speed test would be beneficial.

Test Pulse

We recommend that NHTSA select a pulse that harmonizes with existing industry test protocols. FMVSS No. 202a could be improved by additional harmonization with the UNECE R17 (Rev. 11) or GTR No. 7 head restraint requirements (ΔV = 17.6 km/h).

Injury Assessment Reference Values and Test Repeatability (low speed)

Several factors must be considered regarding injury criteria and test repeatability. The repeatability and reproducibility of the injury criteria suggested for low speed sled simulations are not acceptable for regulation.[13] From an injury mechanism perspective, these criteria are based on measurements made at the occipital condyle of the ATD's and does not address where the soft tissue injury occurs – most studies indicate that they are at the C3-C4 level (nerve block study). Research by Cavanaugh et al. has shown that pain receptors in the cervical spine are in the articular facets.[14,15] Prasad et al. (1997) showed that upper neck ATD responses were not sensitive to impact severity and seat design, but lower neck

---

[10] See footnote 3.

[11] See footnote 4.

[12] Mertz et al. Biomechanical and Scaling Bases for Frontal and Side Impact Injury Assessment Reference Values. Corrected, Republished and Updated as Paper No. 2016-18 in Stapp Car Crash Journal, Vol. 60, 2016.

[13] Bortenschlager et al. Review of Existing Injury Criteria and their tolerance limits for whiplash injuries with respect to testing experience and rating systems. ESV Conference Paper no. 07-0486.

[14] Cavanaugh et al. Pain generation in lumbar and cervical facet joints, J Bone Joint Surg Am, 2006 Apr: 88 Suppl 2:63-67

[15] Barnsley et al. Whiplash Injuries, Pain 58, (1994)

(C7/T1) response was sensitive.[16] Additionally, the study showed a good correlation between lower neck moment and Neck Injury Factor in European vehicles. Another study by Heitzplatz et al. (18th ESV conference) also showed that lower neck moments are good predictors of the NIF in European seats.[17] These were based on tests of only three seats and perhaps more seats should be tested spanning a range of insurance claims in vehicles with modern seats.

Auto Innovators also has concerns about the efficacy of the measurements in preventing actual field injuries and accurately correlating to injury occurrences. Additional evaluations may be needed to understand the best metrics to use in this test that will correlate to real world injury reduction. That being said, whiplash is not a medical condition, so there are no clear standards for diagnosis, and it may not be possible to establish practicable countermeasures for these types of injuries. It also seems necessary to establish a conversion between the behavior of the human body and the dummy in high-speed rear-end collisions, including the repeatability and reproducibility for the dummy's behavior in high-speed rear-end collisions and establish testing methods.

While the agency notes that multiple studies have shown lack of reproducibility in low-speed impacts, we believe the deviation in dynamic tests comes from the use of previous static measurements evaluation procedures. Through static measurement analogous to GTR7/UN-R17/ENCAP, this deviation is no longer present.

Understanding Whiplash Injuries

4.2 High Speed Test

NHTSA seeks comment on various questions to inform the development of a potential high-speed test.

Seat Retention

As discussed in more detail on page 7, above, part of the proposed high speed rear impact test could include a front seat rearward deformation limit related to rear seat occupant space. However, measuring the amount of change in angle of the left and right seatback frames and the displacement of dummy parts in dynamic tests likely requires video analysis, and sled testing would make it easier to measure seat back movement using this approach. To ensure the regulation meets the requirements of the Safety Act and addresses any potential subjectivity in evaluating vehicle compliance, objective, reliable, and accurate testing and analysis methods must be established. In other words, if a limit on occupant to seat displacement is adopted, a robust measurement method is needed. As discussed previously, we recommend NHTSA consider a fixed requirement for seat retention (i.e., a consistent amount of allowable displacement) with appropriate consideration for the stiffness effects and potential for occupants sustaining soft tissue neck injuries.

Test Severity, Test speed, and ATD Configuration

In response to the agency's question on establishing an appropriate test severity and ATD for a potential high-speed test, we recommend the agency adopt a sled test with a generic pulse using the Hybrid III 50th percentile ATD. The primary focus of this test should be to evaluate the extent to which dummy interaction with the seat can be used as a measure for evaluating seat back strength.

---

[16] Prasad et al. Relationships Between Passenger Car Seat Back Strength and Occupant Injury Severity in Rear End Collisions: Field and Laboratory Studies, Proc. of 41st Stapp Car Crash Conference, SAE Paper No. 973343, 1997.

[17] Heitzplatz et al. An Evaluation of Existing and Proposed Injury Criteria with Various Dummies to Determine Their Ability to Predict the Levels of STNI seen in Real Accidents, Proc. 18th ESV Conference, Nagoya, Japan, DOT HS809543, May 2003.

BioRID is not designed for use in high-speed collisions, and it is possible that it may be damaged. Furthermore, testing has not been conducted in high-speed collision ranges, so repeatability and reproducibility is unknown. We recommend using HIII in high-speed sled test, using a pulse similar to FMVSS No. 301, or alternatively, be able to choose from vehicle pulses derived from FMVSS No. 301 testing, if appropriate.

Occupant Posture

NHTSA seeks comment on the appropriate positioning of the ATD in high-speed rear impact testing, and the extent to which out of position (OOP) testing may need to be considered. For standard positioning, we recommend the agency follow the seating procedures outlined in FMVSS No. 208 for the HIII-50M, including belt positioning, if applicable. We do not have a recommendation for OOP occupants as it is unclear which OOP condition is considered to be the most severe in a rear-end collision, and whether this can be easily defined based on available data. Currently only one study of modern seats by Burnett et al. is in public domain comparing ATD injury responses of in-position and OOP occupants. There are a wide variety of OOP configurations, and it may not be possible to determine the "most severe" position due to variation between different sized occupants. NHTSA should engage interested parties in discussing the need for OOP testing and selecting the test positions most likely to be in the field. This process for identifying test positions should be similar to what was conducted in developing the current TWG recommendations for inflatable restraints like side airbags and curtains.

ATD Injury Assessment Reference Values and Kinematics

The agency has requested input on whether existing ATDs can adequately replicate occupant kinematics at higher speeds, and that injury metrics would be most objective and relevant. The durability and robustness of the HIII-50M has been assessed in rear impact loads at high speeds and it has transducers available for injury measurement. Injury criteria are available in the literature for upper and lower neck loads, head, and lumbar spine (Prasad et al. and Mertz et al.).[18,19] Performance criteria should be based on the severity of the test and correlation between real world field data and the predicted injury risk, with consideration for soft tissue neck injuries. Seatback deflection performance could be measured by recording seat back deflection dynamically during the crash event. This would be recorded using video analysis during the rigid fixture sled event by inserting a line in the video extending from the seat back pivot point to a point on top of the seat back and tracking this angle during the rearward portion of the loading event. We also recommend NHTSA utilize HIII-50M ATD as a ballast tool. This is a similar approach to the ballast manikins utilized during FMVSS 301/305 rear impact integrity test. The use of the HIII-95M may not be suitable depending upon the amount of allowable seat rotation permitted.

Characteristics and performance measures needed for rear dummy

Auto Innovators supports the use of the BioRID ATD for low speed testing and the HIII-50M for high speed evaluations. However, with respect to implementation of the BioRID, it is important that consideration be given to minimize the complexity of ATD installation and setup, and to ensure the test procedure addresses any potential sensitivity with the dummy that may impact predicted injury risk due to minor deviations in setup. We also note that the BioRID is only produced by one manufacturer and must be certified as part of Part 572 prior to use in regulation.

---

[18] Prasad et al. Biofidelity of Anthropomorphic Test Devices for Rear Impact, Proc. of 41st Stapp Crash Conference, SAE Paper No. 973342, 1997.

[19] Biomechanical and Scaling Bases for Frontal and Side Impact Injury Assessment Reference Values. Corrected, Republished and Updated as Paper No. 2016-18 in Stapp Car Crash Journal, Vol. 60, 2016.

With respect to the use of female ATDs designed for assessing rear seat back strength, it is expected that the size of the occupant will have more of an effect on safety performance as opposed to any other differences between male and female ATDs. Furthermore, the current EvaRID validation is not sufficiently mature for integration in FMVSS. In addition, the HIII-50M is now generally representative of the current average population of male and female adults, so using this ATD for high-speed rear impact represents both the entire population.

Rear Impact Delivery Method

NHTSA seeks comment on different approaches for delivering a rear impact crash pulse. In general, we support the use of sled testing as it is more reproducible and helps minimize overall test burden while also providing a robust means for evaluating overall seatback strength and performance in rear end collisions. We recommend the agency consider adopting a generic crash pulse representative of a majority of vehicles at a typical rear impact crash speed. This generic crash pulse could be developed by utilizing current vehicle crash pulses at a similar speed as seen in the FMVSS No. 301 and FMVSS No. 305 rear impact integrity test.

A sled-based approach also facilitates early development and testing before complete vehicle models are available, increasing overall design flexibility and the use of seating systems in different vehicle platforms. We note however that rigid platforms have higher stiffness compared to the vehicle interior. This increases acceleration input into seat systems, which increases the severity of the test on the seat structure. As mentioned previously, if a manufacturer can show a different and softer crash pulse in the FMVSS No. 301 test, NHTSA should also consider providing a compliance option to allow manufacturers to use this pulse if it is lower than the generic pulse.

5 Crash Avoidance Technology

Proactive industry efforts have resulted in AEB systems becoming more widespread across the vehicle fleet. While there is safety benefit in considering a regulated high-speed test in FMVSS No. 207, with the increasing prevalence of crash avoidance technologies, we expect both the frequency and severity of rear-end collisions to decrease over time. However, there is limited field data to make a robust determination on the impact of these systems and how they might be considered in the context of FMVSS No. 202a and FMVSS No. 207, at this time. NHTSA should assess the extent to which the safety need may change over time, and whether rear impact protection requirements should be revised. For example, in the future, we recommend the agency conduct an effectiveness study of crash avoidance technologies to determine if a reduced test speed is appropriate.

Additionally, as noted in Auto Innovators comments in response to the AEB-PAEB rulemaking, we also have concerns regarding the extent to which the automatic braking requirements may result in potential disbenefits, such as rear-end collisions induced by the stringent braking requirements. For example, occupant kinematics and initial position could be negatively affected by aggressive braking. If the occupant is pitched forward, the space between their head and back to the headrest and seatback increases which can lead to different injury outcomes. Additionally, there may be a need to adjust seatback strength to account for (or make up for) a less desirable initial position while maintaining occupant safety.

6 NHTSA Forthcoming Research

Auto Innovators supports the agency's continued focus on research to ensure a data driven approach to rulemaking that both improves upon the requirements of the existing standard, while limiting the potential for unintended consequences. This is critical for ensuring the success of this rulemaking. We also support the agency's two-tiered dynamic testing approach as proposed in the ANPRM, and encourage the agency to publish the findings of its research as soon as practicable ahead of any future NPRM. Furthermore, we encourage the agency to publish a more comprehensive overview of its planned research on seat back strength in the docket, as soon as practicable. The agency should also consider providing updates as part of any planned NHTSA public meetings on its research portfolio.

Field Data Analysis and Market Research

Auto Innovators supports additional NHTSA efforts to evaluate the design characteristics of contemporary seating systems, and to conduct further real world data analysis to assess the performance of modern seat designs on occupant injury outcomes in both front and rear row seating positions. This analysis should also inform the development of the agency's regulatory impact analysis to assess the expected market impacts as a result of future requirements going into effect.

The ANPRM notes that NHTSA also intends to examine how seat designs may have improved across the fleet or how second row seats differ in performance from front row seats. This research is important for understanding differences in performance in the field, but we again recommend that this research focus on contemporary seat designs. We also request that the agency provide clarification in the NPRM regarding the extent to which FMVSS requirements may be applicable to second row seating (for two-row vehicles), and second- and third-row seating (for three row vehicles).

Test Procedure Assessment

Auto Innovators provides the following comments on the test procedure assessment.

a. *High-Speed Test*
   Additional real-world data analysis is needed to understand real world injury risks in higher-speed collisions. However, the agency should ultimately seek to ensure that any derived test conditions, including sled test speed, remain consistent with other regulations. We suggest using an extracted pulse from the vehicle and use this as a basis for performing a sled based test.

b. *Exploratory Testing*
   We recommend NHTSA consider additional research to evaluate the use of the BioRID and HIII-50M for predicting soft tissue neck injuries in low-speed rear impacts ranging from 8-24 km/h delta-V with instrumentation to evaluate sensor data for both the upper and lower neck. ATD responses (e.g., at the upper and lower neck, thoracic and lumbar load cells) should be compared with real-world data (e.g., whiplash injury insurance claims) when considering the development of injury criteria.

c. *Low-Speed Test*
   We support the use of the BioRID ATD for low-speed testing and recommend the agency consider incorporating the GTR No. 7 requirements for establishing the speed and crash pulse conditions for sled testing.

Parametric Modeling

Auto Innovators generally agrees with the use of modeling to verify seat back performance, it is important that the regulation assess the practicability of multiple parameters, particularly those used to evaluate compliance with the Standard.

ATD and Injury Risk Function Development

As noted previously, the introduction of new ATDs should be carefully considered and must provide an accurate representation of the expected occupant kinematics and/or potential injury risks when evaluating seat performance under various crash or sled test conditions.

Expert stakeholder engagement

Auto Innovators supports NHTSA efforts to modernize the existing seat back strength requirements, but recognize the complexity in developing a rule to update both FMVSS No. 202a and FMVSS No. 207 and the importance of ensuring that updates are implemented carefully to avoid unforeseen outcomes. Our members have extensive experience in designing modern seating systems, and continue to invest in the research and development of new and innovative designs. To the extent that there are unresolved questions following the agency's planned research, we would welcome the opportunity to provide additional input through expert stakeholder workshops, or similar forums, to help ensure the agency has sufficient information in the development of its proposed rule. To the extent we identify additional research or data that may be relevant, we will plan to provide this to the agency through supplemental comments.

Please contact me if you have any questions.

Sincerely,

Sarah Puro
Vice President, Safety and Technology Policy
Alliance for Automotive Innovation