INSURANCE INSTITUTE
FOR HIGHWAY SAFETY

July 13, 2004

The Honorable Jeffrey W. Runge, M.D.
Administrator
National Highway Traffic Safety Administration
400 Seventh Street, S.W
Washington, D.C. 20590

Dear Dr. Runge:

On December 19, 2002, the Insurance Institute for Highway Safety (IIHS), supported by the University of Michigan Transportation Research Institute (UMTRI), petitioned the National Highway Traffic Safety Administration (NHTSA) to amend the driver dummy seating procedures in Federal Motor Vehicle Safety Standard (FMVSS) 208, FMVSS 214, and the New Car Assessment Program (NCAP) crash tests. In the petition we requested that NHTSA adopt a new procedure placing test dummies in positions and postures more representative of where similar-size human drivers actually sit, compared with placement according to NHTSA's current practice. The agency's procedure is based on seat-track features having no influence on the preferred fore-aft seat positions of most drivers who are represented by the different sizes of test dummies. Consequently, in most vehicles the dummies are positioned in fore-aft locations that are unlikely to be chosen by similar-size drivers and that are inconsistently related across vehicles to representative driver positions.

We are writing this letter in response to NHTSA's denial of our petition, published in the *Federal Register* (Vol. 69, No. 35) on February 23, 2004, because we strongly believe the agency's analysis of the information provided in our petition, as reflected in the rationale offered for the denial, is seriously flawed by errors and misunderstandings. We therefore request that NHTSA reconsider our petition and its initial decision upon reviewing this response and the clarifications of the issues involved.

In particular, NHTSA failed to understand that our recommended procedure is based on data obtained from extensive studies of driver seating preferences, which clearly demonstrate that the relative positions of driver primary controls (steering wheel and pedals) and seat height, as indicated by the H30 package dimension, have significant effects on where drivers of various statures are most likely to sit (Flannagan et al., 1998; Manary et al., 1998). The agency also failed to acknowledge that its current practice is based

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only on vehicle seat-track features (front, middle, and rear) that do not influence most drivers' preferred seating positions and that are arbitrary and open to manipulation by vehicle manufacturers to achieve test results that do not accurately reflect the crash protection provided to most similar-size drivers. Moreover, crashworthiness assessments provided by FMVSSs 208 and 214 and NCAP are inconsistent across vehicles because they vary as a function of the degree to which the dummy seating position is manipulated by seat-track design and positioning.

In reading NHTSA's response to our petition, we found it perplexing that the agency is disputing the relevance of the large body of driver-positioning data used to develop our proposed dummy seating procedure. At the same time, the agency is failing to acknowledge that its current procedure is based on absolutely no information about driver positions. Our proposed procedure was based on extensive research at UMTRI that involved surveying the preferred driving positions of volunteers in 36 different vehicle models with 60 to 120 volunteers measured in each vehicle. NHTSA presented no similar body of research to support the contention that its dummy seating procedure represents human driver behavior. Furthermore, NHTSA failed to acknowledge the specific examples cited in our petition that demonstrate how vehicle designs can exploit the arbitrary nature of the agency's current seating procedure to achieve crash test results that are different from those that would be obtained if the test dummies were seated in positions more representative of where similar-size drivers typically would sit.

In its denial of our petition, NHTSA claimed that its current seating procedure produces worst-case occupant loading in crash tests, compared with the more rearward positions specified by our proposed procedure. However, the agency presented no test data to support this claim. Instead, it argued that the small female dummy sitting at the forward-most position allowed by the seat track is more likely to interact with a deploying airbag than if the dummy were seated farther rearward. Although this may be true, FMVSS 208 now includes numerous tests to assess the risk of airbag deployment injuries to out-of-position vehicle occupants. We therefore contend that full-scale crash tests should not be used to assess worst-case airbag loading, but should assess the protection afforded to the majority of drivers represented by the test dummy; therefore, the dummies should be seated in representative positions, not in hypothesized worst-case airbag-loading positions.

Furthermore, it is incorrect and naive to assume that sitting farther forward always constitutes a worst-case scenario. For example, NHTSA's claim that a more forward-seated midsize male test dummy will

experience more severe crash loading is erroneous. Sitting farther rearward than mid-track would allow a midsize male dummy, especially an unbelted one, to have greater velocity with respect to more forward components of the vehicle. It also would probably increase the likelihood that the dummy would move around the airbag and thus interact with vehicle interior components, as is commonly seen in real-world crashes involving unbelted drivers.

The examples of likely seat-track manipulation presented in our petition are evidence that many manufacturers also understand that it is easier to pass the regulatory crash tests with the midsize male dummy seated farther forward. Every one of these examples -- blocking otherwise usable rearward portions of the seat track with spring clips and adding unusable sections of track to the forward end -- has the effect of seating the dummy more forward than drivers of similar size typically would choose to sit.

Finally, NHTSA is simply incorrect in stating that our proposed procedure “would place the seat outside of the physical limitation of the seat track.” This statement is based on two observations about data presented in our petition. The first is that many of our examples for the large (95th percentile) male predict a preferred seating position more rearward than allowed by full-rearward adjustment of the seat. It should not be surprising that the largest drivers may not be able to achieve their preferred driving positions in some vehicles, especially smaller ones, especially when manufacturers may have adjusted seat-track travel to achieve optimal crash test results rather than to accommodate driver positioning needs. However, the procedural document we submitted with our petition indicates that when the calculated position cannot be reached the seat should be adjusted as close to the calculated position as possible, which in these cases would be the most rearward position.

NHTSA’s second erroneous observation was based on the fact that many calculated seating positions for the midsize male dummy are lower than the mid-track, full-down adjustment used as a reference for the seating calculations. In making this observation, NHTSA analysts failed to recognize that most vehicle seat tracks are angled such that more forward positions are higher than those to the rear. Because our proposed procedure usually calculates a midsize male position that is rearward of mid-track, the calculated positions also are lower. It is disappointing that NHTSA analysts, confused by these results, did not contact IIHS or UMTRI researchers for clarification before deciding our proposed procedure was invalid.

In short, we find NHTSA’s reasons for denying our petition unjustified. The attachment to this letter contains more detailed

responses to each of the arguments used by NHTSA to justify denial of our petition. We strongly urge the agency to review these responses and reconsider the original petition.

Sincerely,

Adrian K. Lund, Ph.D.
Chief Operating Officer, IIHS

Lawrence W. Schneider, Ph.D.
Research Professor
Head, Biosciences Division, UMTRI

Attachment

References

Backaitis, S.H.; Hicks, M.E.; Prasad, P.; Laituri, T.; and Nadeau, J. 1995. Variability of Hybrid III clearance dimensions within the FMVSS 208 and NCAP vehicle test fleets and the effect of clearance dimensions on dummy impact responses. SAE Technical Paper Series 952710. Warrendale, PA: Society of Automotive Engineers.

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Manary, M.A.; Reed, P.R.; Flannagan, C.A.C.; and Schneider, L.W. 1998. ATD Positioning based on driver posture and position. SAE Technical Paper Series 983163. Warrendale, PA: Society of Automotive Engineers.

Attachment

> NHTSA argument 1: *"…the agency believes that the current procedure appropriately represents positions where 5th and 50th percentile occupants may sit."*

IIHS and UMTRI agree that 5th and 50th percentile occupants may sit in full-forward and mid-track positions, but several studies have shown that most drivers of the statures represented by small female and midsize male test dummies will sit farther rearward of these positions. One of these studies was, in fact, sponsored by the U.S. Department of Transportation and co-authored by two NHTSA staff members. This study concludes that "real world occupants select a seat location somewhat rearward [36 mm on average] from the mid-track position setting which is currently used to locate the dummy in FMVSS 208 and NCAP crash tests" (Backaitis et al., 1995). One of the recommendations posed by the authors is that, in order to "optimize occupant protection in the crash environment, placement of dummies should be considered in seating positions that are based on selections by real world occupants."

The primary goal of the UMTRI procedure is to position the driver dummy based on factors of vehicle interior package geometry that are known to influence actual driver positioning. This is in contrast to NHTSA's current procedure of allowing arbitrary fore-aft positioning that can be manipulated by manufacturers to optimize crash test results. NHTSA mandates a small number of tests intended "to assess safety protection for all sizes of occupants." Yet these assessments are inconsistent across vehicles because the mid-track and full-forward positions are located inconsistently with respect to the actual distributions of driving positions. The UMTRI procedure ensures that different-size dummies are tested at the same percentiles of driver seat-position distributions in each vehicle, instead of allowing dummy test positions to be determined by manufacturers in ways that result in significant inconsistencies relative to the distributions of actual driver positions.

> NHTSA argument 2: *"NHTSA believes the full-forward position is appropriate for the 5th percentile female dummy because it represents the worst-case scenario for air bag-induced injuries in high severity crashes… Likewise, the agency believes the mid-track positioning of the 50th percentile male dummy is an acceptable position that represents where an adult-sized occupant may sit. A further rearward displacement of the dummy reduces the likelihood that the dummy will significantly interact with the interior of the vehicle, particularly since braking dynamics in most real-world crashes will move the occupant forward of the pre-braking seating position."*

The full-forward position does not necessarily present the worst-case scenario for small adult women. Nor does a position farther rearward of mid-track reduce the likelihood of a 50th percentile male dummy

interacting with the vehicle interior and restraint systems in an injurious manner. For example, sitting farther rearward allows a dummy's head and chest to gain greater velocity with respect to the steering wheel prior to contact with the airbag. This rule also applies to knee contact with the knee bolster or other parts of the interior compartment. There is ample evidence from the interior package layouts of current vehicles that manufacturers believe it is easier to pass the crash certification tests with the midsize male dummy at a mid-track position that has been adjusted to produce optimal results, rather than at the mean expected seating position for midsize males. In some vehicles, manufacturers have added largely unusable seat track at the front to bring the midsize male dummy forward, even though it has no effect on the seating positions of midsize men or any other driver, for that matter.

In NHTSA's dummy positioning procedures, the forward position of the small female dummy also is limited by knee-bolster clearance. Thus manufacturers have considerable discretion concerning where dummies will be positioned for testing, irrespective of where drivers actually would sit in the vehicles. Positioning of the midsize male dummy can be controlled by adjusting the front of the seat track, whereas positioning of the small female dummy can be controlled independent of the seat track by adjusting the bolster location.

In making the point about positioning dummies for worst-case scenarios, NHTSA also failed to consider the effects that the choice of dummy position has on restraint system design. If midsize male dummies were positioned more realistically (i.e., more rearward in most vehicles), manufacturers would need to do a better job of managing seat belt loads in belted frontal tests –- i.e., the dummy would load the belt substantially more than is the case under the current test procedure. Because manufacturers can adjust the fronts of seat tracks to bring a dummy's chest to the edge of the airbag deployment envelope, the dummy "sees" less belt loading than the majority of midsize men would experience in the same crash -- i.e., most midsize men (thus most men) sit rearward of the current dummy position. Testing at mid-track may lead to suboptimal force-limiting belt system designs.

Finally, there is no basis for NHTSA's argument that braking dynamics will move a driver forward of the pre-braking seating position. In fact, it is likely that at a level of braking less than 1 g, precrash bracing by a driver will prevent the forward movement that is more likely to occur with an unaware passenger.

> NHTSA argument 3: "*IIHS does not give compelling evidence to conclude that the UMTRI seating procedure is more reflective of real-world behavior compared to the current agency procedure. Because many results in Appendix D of the petition would place the seat outside of the physical limitation of the seat track, the agency believes that the UMTRI results do not accurately depict real-world behavior in many cases.*"

As noted above, the UMTRI procedure for dummy fore-aft positioning is based on a large database of actual driver positions in a diverse group of vehicles. This is clearly “compelling evidence” that the dummy positions of the proposed procedure are more representative than the hardware-based positions obtained with the current procedures. In Manary et al. (1998) and Backaitis et al. (1995), the mid-track and full-forward positions were shown to be substantially different from “real-world” driver positions. Surely this evidence is more compelling than the implicit argument that seat-track-based dummy positions “accurately depict real-world behavior.”

Of course, for dummy positioning a predicted position that is off the track would be censored to the actual track travel, just as it would be for real occupants, thereby ensuring the dummy position is representative of the position of similar-size drivers. In the original paper on the development of the UMTRI dummy positioning model (Manary et al., 1998), analysis of data from driver-selected seat positions in vehicles showed that, in some vehicles, the seat-track adjustment range prevented some (usually tall) drivers from sitting in the positions they preferred. This “censoring” was particularly common at the rearmost position on the seat track, where a relatively large number of driver-selected seating positions would be observed.

It also should be noted that the example presented in the petition denial (2001 Dodge Grand Caravan) is not a case where the UMTRI procedure would place the seat outside of its physical range; thus it is not a case in which “censoring” has occurred. The data presented in Appendix D of the petition show how a dummy’s H-point position would change with respect to the mid-track position, not how the seat would move beyond the full-rear full-down position. Because most seat tracks are sloped (seat height drops as the seat is moved rearward), it is possible to have a lower H-point in the position prescribed by the new procedure than in the mid-track position. The 2001 Dodge Grand Caravan manual seat drops approximately 22 mm over the 149 mm horizontal range, so it makes sense that if the seat is moved 64 mm rearward to obtain the test position, it also would drop vertically.

> NHTSA argument 4: *“NHTSA believes that the regression analysis used by UMTRI is an appropriate tool to observe trends in data, but is not by itself sufficient to define a procedure that will affect all vehicles under FMVSS Nos. 208 and 214. Several points support this agency belief. First, the formula representing the regression is based on a finite number of vehicles. Although different sizes of vehicles were included in the study, the formula would change as other vehicle seating positions are studied.”*

The data on which the proposed UMTRI procedure is based were gathered from vehicles in all of the important categories; sports cars, pickup trucks, sedans, SUVs, and minivans are represented. While using more data from additional and future vehicles could result in a slightly different statistical model, it is unlikely to result in any

significant change in the positions predicted for drivers and crash dummies of various sizes.

The suitability of the statistical approach used in developing the UMTRI procedure from the driver-position and package geometry data is addressed comprehensively by Flannagan et al. (1998). All of the important assumptions underlying the linear regression model are supported by these data. It is therefore difficult to understand the agency's contention that the rigorous approach used to develop the proposed crash dummy positioning procedure is insufficient, given that the agency's current procedures are not based on <u>any</u> information about where different-size drivers sit in different vehicles.

NHTSA's argument that "the formula would change as other vehicle seating positions are studied" is not pertinent to this petition as it only addresses driver dummy positioning at this time.

> NHTSA argument 4 (continued): *"Also, the regression formula would change as the fleet characteristics would change over time. There is no guarantee that equations derived from data collected in the past would apply to vehicles in the future. Outlying data points in the data today may become more frequent, causing additional practicability issues."*

The vehicles used in the UMTRI studies were chosen carefully to span a large range of important vehicle interior variables, particularly those that affect driving position, notably seat height and steering wheel position. The vehicles were even selected to span a large range of steering-wheel-to-pedal distances within each seat height range to capture the important orthogonal variance for these two variables that are significantly correlated across the vehicle fleet. Thus, it is extremely unlikely that the interior package geometries of vehicles in the foreseeable future will vary significantly from the range of package geometries in the vehicles used to establish the UMTRI procedure.

Moreover, the applicability of the model is unaffected by the composition of the vehicle fleet because it is applied to the dimensions of each individual vehicle in which it is used. Although there can be "no guarantee" with any empirical prediction, there is no reason to believe that "outlying points" in the data would become more frequent and good reason to believe the opposite, given the span of vehicle configurations already in the database.

The evidence by Manary et al. (1998) strongly suggests that, compared with dummy positions produced by NHTSA's current procedures, dummy positions based on the UMTRI procedure will be (1) significantly more representative of the positions of similar-size drivers, and perhaps more importantly (2) dummies will be more consistently located with respect to the actual distributions of driving positions across vehicles. As a result, NHTSA's assessments of the safety performance of vehicles will be more meaningful to regulators and to the public.