INSURANCE INSTITUTE
FOR HIGHWAY SAFETY

October 14, 2004

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

Notice of Proposed Rulemaking
Federal Motor Vehicle Safety Standards; Side Impact Protection;
Side Impact Phase-In Reporting Requirements
Docket No. NHTSA-2004-17694

Dear Dr. Runge:

The National Highway Traffic Safety Administration (NHTSA) has issued a notice of proposed rulemaking (NPRM) that would amend Federal Motor Vehicle Safety Standard (FMVSS) 214, Side Impact Protection. The Insurance Institute for Highway Safety (IIHS) welcomes the opportunity to comment on the agency's efforts to upgrade this important standard. NHTSA proposes both moving deformable barrier (MDB) and pole tests using midsize male and small female test dummies that, in theory, would improve protection for vehicle occupants of varying statures over a range of side impacts. However, IIHS believes the proposed rule will achieve its full promise only if the MDB design is updated to better reflect side impact risks in the current vehicle fleet and if the dummies used in the testing are reasonably biofidelic and include deflection-based injury measures.

Updating the MDB

The proposed MDB for the new rule, NHTSA's current FMVSS 214 MDB, is generally representative of a modern car in height, but its wide, square shape is representative of no current vehicles in terms of the way it spreads the load of an impact across the A-, B-, and C-pillars of a struck vehicle. To represent the real risk in multiple-vehicle side impacts, a barrier needs to represent the ride height and overall height of sport utility vehicles (SUVs) and pickups, which are much more dangerous in side impacts than cars and are increasingly prevalent in the fleet. In addition, the front of the barrier needs to be contoured so the loading pattern on the side of the struck vehicle is more similar to the kind of loading that occurs in real impacts with vehicles whose front shapes are contoured. IIHS began conducting research toward the development of such a barrier and a side impact crashworthiness evaluation program for consumer information in 1999. We published our first comparisons of side

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impact crashworthiness among new vehicles in 2003. The various phases of this development program have been documented previously (Arbelaez et al., 2002a, 2002b; Dakin et al., 2003). In the IIHS test, an MDB strikes the driver side of a stationary vehicle at 50 km/h (31 mi/h); the MDB weighs 1,500 kg, and the deformable element is shaped to represent the front end of a typical SUV or pickup.

The IIHS barrier design is based on the FMVSS 214 barrier, but it is raised 10 cm from the ground and made 20 cm taller; this makes the IIHS barrier's top surface 30 cm higher than that of the FMVSS 214 barrier. The ride height of the IIHS barrier's bumper element is aligned closely with the lower edges of SUV and pickup bumpers measured at the time the IIHS barrier was designed (Arbelaez et al., 2002a). In addition to the changes made to the side view of the IIHS barrier, the front profile was contoured in the overhead view with simple 24.5-degree chamfers to represent the curved bumper geometry observed in the SUVs and pickups. A side-by-side illustration of the FMVSS 214 and IIHS barriers is shown in Appendix A, Figure A-1.

Although the stiffness characteristics of the deformable element used in the IIHS barrier are identical to those used in the FMVSS 214 barrier, vehicles tested with these two barriers respond very differently. The FMVSS 214 barrier's lower ride height allows it to engage the door sill structure of the struck vehicle, and the flat front-end profile of the barrier engages the A- and C-pillar structures earlier in the crash. Because the IIHS barrier has a higher ride height and a contoured overhead profile, the primary load path on the struck vehicle is the B-pillar. There is more door intrusion, and the higher intruding barrier face poses a significant risk to the heads of occupants in the struck vehicle. During the past two years, IIHS has seen considerable improvements by some manufacturers in stiffening B-pillar structures along with roof rails and door sills. By continuing to use the current FMVSS 214 barrier, NHTSA will not be driving these improvements in structural designs that can benefit occupants in real-world side crashes.

In addition to driving design improvements, the IIHS side impact test has achieved acceptance among vehicle manufacturers. Many of the major automakers have independently validated the IIHS barrier using their own SUVs and pickups and consequently have adopted the IIHS test into their internal test requirements. In addition, the manufacturers of virtually all vehicles sold in the United States have voluntarily agreed to adopt the head impact requirements of the IIHS test procedure as part of the Enhanced Vehicle Compatibility commitment (Alliance of Automobile Manufacturers, 2003). The IIHS barrier is gaining acceptance among international safety groups as well. In July 2004, the International Harmonized Research Activities (IHRA) Side

Impact Working Group (SIWG), of which NHTSA is a participating member, presented draft test procedures that included the IIHS barrier as one of the two barriers currently being considered.

Because of this widespread acceptance and because the IIHS barrier better reflects the types of vehicles increasingly likely to cause serious injury in side impact collisions, we urge the agency to replace the now long out-of-date NHTSA MDB with the IIHS barrier for this rule. Rarely does such an opportunity for harmonized advancement of vehicle testing standards present itself. If the agency does not take this opportunity to improve the barrier and if it decides to accept less biofidelic dummy options (discussed next), it is difficult to see what benefits will accrue from the additional MDB tests that have been proposed.

Performance Criteria

IIHS strongly supports the use of deflection measures to assess side impact chest injury risk. We are dismayed that NHTSA proposed this new standard without deflection-based injury metrics for the small female dummy. Overwhelming biomechanical data exist that show chest deflection to be a superior predictor of injury risk compared with acceleration-based metrics. The countermeasures that manufacturers install to reduce acceleration-based injury metrics in FMVSS 214 could adversely affect deflection-based injury measures. The inclusion of deflection criteria in FMVSS 214 is long overdue and would finally bring this standard to levels found in Europe and elsewhere.

Choice of Side Impact Dummies

Although IIHS has not conducted any tests with ES-2re, we have considerable experience with many 50th percentile male side impact dummies including SID, SID-H3, BioSID, and EuroSID-1. IIHS supports the general principle that side impact protection is most likely to be improved when test instruments are more biofidelic. Therefore, IIHS supports the adoption of ES-2re as the test device representing the midsize male over the antiquated SID and SID-H3 dummies, which have poor biofidelity ratings. WorldSID might be an even better alternative in the future, but developmental testing is not complete on this new, state-of-the-art dummy, and therefore the time is not ripe for its inclusion in rulemaking. Nor is it necessary in order for the agency to toughen the requirements for protection of the midsize male in side impacts.

In no case should the agency prolong the use of the outmoded SID and SID-H3 dummies in rulemaking that will affect crash protection for the next decade. IIHS strongly believes that the agency’s stated willingness to consider using SID-H3 in place of ES-2re if all of the injury measures available in ES-2re are not adopted into the final

rule is misplaced. NHTSA defends this position by stating that SID-H3 has been used for years in FMVSS 201 and is “acceptably biofidelic as a test device.” IIHS would point out that the biomechanics knowledge base and dummy designs have improved considerably during the past 20 years. What once was considered “acceptably biofidelic” no longer stands up to current dummy standards. ES-2re offers more sensitive information on rib deflection characteristics and pelvic loading that simply is unavailable from SID-H3, and such a compromise is unwarranted. If those injury measures cannot be used, the agency needs to reassess what benefits, if any, can accrue from the proposed changes in test procedures. In the view of IIHS, very little would be gained, at least in the proposed MDB tests.

A similar issue pertains to the floating rib guide (FRG) modification in the small female dummy currently proposed by NHTSA. There is serious concern that the FRG modification, intended to enhance dummy durability, has considerably degraded the SID-IIs dummy’s biofidelity. This is reflected in NHTSA’s decision not to incorporate rib deflection data for this dummy at this time, even though similar data for the original SID-IIs are widely accepted. (The technical details of these concerns are discussed thoroughly in Appendix B. They indicate that SID-IIsFRG is not a promising dummy development.) At the same time, IIHS experience with the original SID-IIs has shown this dummy to be durable in very severe full-vehicle crash tests, raising doubt about the need for floating rib guides in the first place. As a result of these observations, IIHS does not support the agency’s move to incorporate the modified SID-IIsFRG dummy into its side impact crash protection rulemaking. Instead, we recommend that NHTSA adopt the original SID-IIs (build level C) or SID-IIs-enhanced (build level D), which currently is being reviewed by the Occupant Safety Research Partnership (OSRP) SID-IIs Upgrade Task Group. Build level D would incorporate many of the design upgrades currently in the FRG version that would improve the dummy while maintaining its high biofidelity rating. The changes IIHS supports for build level D include redesign of the shoulder rib and rib guide, neck mounting bracket, rib stops, and spine box. Using SID-IIs in either build level would permit the agency to incorporate rib deflection data in test requirements with this rulemaking, an important step forward in protecting small female occupants in side impacts.

The Pole Test

IIHS agrees there should be a pole test requirement as part of FMVSS 214 to ensure occupants are protected in side impacts with narrow objects such as trees or poles. In addition, the agency’s proposal to test with both small female and midsize male dummies would help ensure that head protection is available to occupants regardless of stature.

One concern about the pole test proposal is that the proposed dummy positioning in the tests may negate the purpose. The purpose of testing with both small female and midsize male dummies is to assure head protection for occupants spanning the range of statures of these two dummies. However, NHTSA proposes to position the seat for the midsize male in the middle of the fore-aft seat track. Typically, midsize males sit a little farther rearward (in some cars, two or more inches rearward) of the midpoint. For this reason, IIHS (2002, 2004) and the University of Michigan Transportation Research Institute have petitioned the agency to use a different seating procedure for the midsize male dummy in crashworthiness tests. We have asked NHTSA to use a procedure that more accurately reflects where such occupants actually sit. The same arguments apply here. If the agency instead uses the midpoint of the seat track to position the midsize male dummy, then the range of occupant sizes protected by mandated head protection will not be as large as intended by the agency.

In summary, IIHS strongly supports NHTSA's intention to strengthen side impact protection. However, it should be clear from these comments that IIHS also believes (if the agency's intention is to be realized) that the moving deformable barrier needs to reflect the kinds of vehicles (SUVs and pickups) most likely to cause injuries in side impacts; the dummies need to be biofidelic and offer sensitive measures of the risk of chest and head injury (ES-2re and SID-IIs are the clear choices; SID and SID-H3 are antiquated designs that should not be carried forward into crashworthiness standards of the future, and SID-IIsFRG is a step backward in biofidelity that offers no commensurate promise of greater future utility); and the dummies should be positioned where real people would sit (otherwise we are protecting dummies, not people). The proposed pole impacts offer a chance to assure that future head protection spans a wide range of occupant sizes.

We hope these comments help the agency strengthen the proposed rule. We are open to the agency's requests for additional information or data from our side impact evaluation program.

Sincerely,

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

cc: Docket Clerk, Docket No. NHTSA-2004-17694
Attachments: Appendices A and B

References

Alliance of Automobile Manufacturers. 2003. Enhancing vehicle-to-vehicle crash compatibility: a set of commitments for progress by automobile manufacturers. Washington, DC. Available: http://autoalliance.org/archives/000099.html.

Arbelaez, R.A.; Dakin, G.J.; Nolan, J.M.; Dalmotas, D.J.; and Tylko, S. 2002a. IIHS side impact barrier: development and crash test experience. *IMechE Conference Transactions: International Conference on Vehicle Safety 2002*, 73-88. London, United Kingdom: Professional Engineering Publishing Ltd.

Arbelaez, R.A.; Nolan, J.M.; Dakin, G.J.; and Lund, A.K. 2002b. Comparison of EuroSID-2 and SID-IIs in vehicle side impact tests with the IIHS barrier. Report no. SAE 2002-22-0019. *Stapp Car Crash Journal* 46:397-415.

Braver, E.R. and Kyrychenko, S.Y. 2004. Efficacy of side airbags in reducing driver deaths in driver-side collisions. *American Journal of Epidemiology* 159:556-64.

Dakin, G.J.; Arbelaez, R.A.; Nolan, J.M.; Zuby, D.S.; and Lund, A.K. 2003. Insurance Institute for Highway Safety side impact crashworthiness evaluation program: impact configuration and rationale. *Proceedings of the 18th International Technical Conference on the Enhanced Safety of Vehicles* (CD-ROM). Washington, DC: National Highway Traffic Safety Administration.

Insurance Institute for Highway Safety. 2002. Petition concerning occupant crash protection (49 CFR 571.208) and side impact protection (49 CFR 571.214). Submitted to the National Highway Traffic Safety Administration, September 5, 2002. Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 2004. Petition concerning denial of original petition (September 5, 2002) regarding dummy seating positions in tests for occupant crash protection. Submitted to the National Highway Traffic Safety Administration, July 13, 2004. Washington, DC: U.S. Department of Transportation.

Maltese, M.R.; Eppinger, R.H.; Rhule, H.H.; Donnelly, B.R.; Pintar, F.A.; and Yoganandan, N. 2002. Response corridors of human surrogates in lateral impacts. Report no. SAE 2002-22-0017. *Stapp Car Crash Journal* 46:321-51.

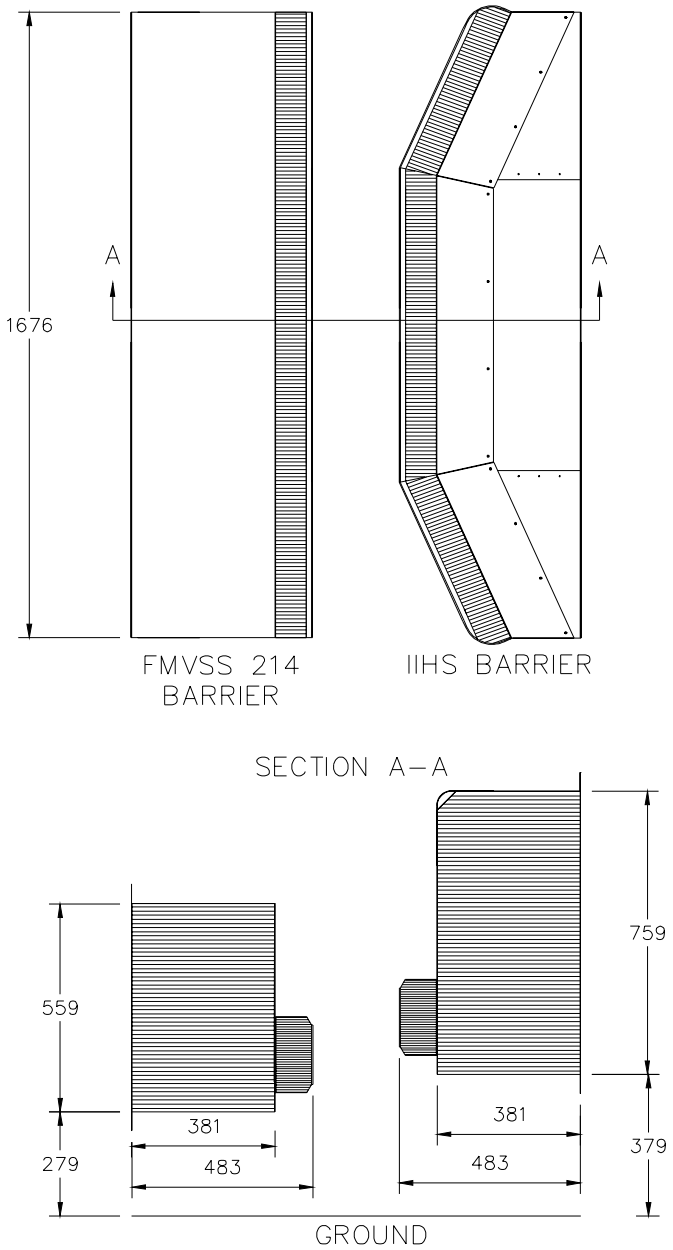
Rhule, H. and Hagedorn, A. 2003. Development of the SID-IIs FRG. Comment to the National Highway Traffic Safety Administration concerning FMVSS 214, side impact protection, Docket no. NHTSA-2004-17694-14. Washington, DC: U.S. Department of Transportation.

Scherer, R.D.; Kirkish, S.L.; McCleary, J.P.; Rouhana, S.W.; Athey J.B.; Balser, J.S.; et al. 1998. SID-IIs Beta+-prototype dummy biomechanical responses. Paper no. SAE 983151. *Proceedings of the 42nd Stapp Car Crash Conference*, 89-114. Warrendale, PA: Society of Automotive Engineers.

Tylko, S. and Dalmotas, D. 2004. SID-IIs response in side impact testing. Paper no. SAE 2004-01-0350. *Rollover, Side, and Rear Impact* (SP-1880). Warrendale, PA: Society of Automotive Engineers.

APPENDIX A

Figure A-1 - Top and Side Cross-Sectional Views of FMVSS 214 (left) and IIHS (right) Barriers; All Measurements are in Millimeters



APPENDIX B

SID-IIs vs. SID-IIs FRG

To date IIHS has conducted 48 side impact crashworthiness evaluation tests with SID-IIs dummies positioned in the driver and rear outboard seating positions, for a total of 96 SID-IIs exposures in this test configuration. Of these there are 6 cases in which some damage to the dummy occurred during the test (4 cases of damage to the dummy's shoulder rib and 2 cases in which one of the abdominal ribs did not pass post-test verification).

In its FMVSS 214 NPRM, NHTSA has proposed using a modified version of the SID-IIs dummy, SID-IIsFRG, which among other changes includes a floating rib guide (FRG) system. An agency report, "Development of SID-IIs FRG," indicates dummy durability issues as the reason for modifying the SID-IIs dummy (Rhule and Hagedorn, 2003). The report states:

> If a dummy is not durable enough to withstand the laboratory testing designed to evaluate it, it is possible that damage may occur in the crash environment. If damage to the dummy occurred in an FMVSS 214 test and the vehicle failed a test criterion, the damaged part of the dummy could be responsible for the test results rather than the performance of the vehicle's safety systems.

The laboratory sled tests conducted by NHTSA, in which the original SID-IIs durability was deemed to be inadequate, involved an extremely severe load and load path to the dummy that is not representative of the loading environment an occupant would experience in a full-vehicle side crash. The offset distance of 100 mm used for the abdominal and pelvic offset plates in the sled tests was based on the offset distance used by Maltese et al. (2002) to determine response corridors for midsize male human subjects in lateral sled tests. The abdominal and pelvic offset distance used in the agency's sled tests should have been scaled to account for the size difference between 50th percentile males and 5th percentile females. The selection of the 100 mm offset distance also is questionable considering the fact that SID-IIs thoracic and abdominal ribs have a maximum deflection limit of 70 mm. The report by Rhule and Hagedorn (2003) concludes that the original SID-IIs "rib stops were ineffective and would need modification." In reality, NHTSA should have concluded that the sled test configuration was unrealistic, extremely severe, and not representative of an in-vehicle leading scenario.

The FRG modification has been incorporated by the agency to fix a problem that is limited to the sled test configuration mentioned above. Full-scale barrier and oblique pole side crash tests conducted by NHTSA have yet to show any durability issues with the dummy. Furthermore, IIHS researchers have concluded that the dummy damage occurring in IIHS tests would not have been prevented by the FRG

system. Dummy data from IIHS tests also have been pooled into a dummy damage database organized by the Occupant Safety Research Partnership (OSRP) SID-IIs Upgrade Task Group. Similar trends are found in the dataset from the OSRP group, which includes 241 SID-IIs exposures (or 1,446 exposures to thoracic, abdominal, and shoulder ribs in the original SID-IIs) from full-vehicle crash tests conducted by General Motors, DaimlerChrysler, Transport Canada, and IIHS. The OSRP data indicate that only 1.2 percent of the reported SID-IIs exposures (0.3 percent of total rib exposures) show evidence of the ribs exiting the guides. Additionally, in cases where some form of dummy damage was reported (7.5 percent of SID-IIs exposures) there is no evidence of the ribs exiting the guides. This indicates the FRG system would not improve the SID-IIs dummy's durability in full-vehicle crash tests.

IIHS takes issue with the FRG system, primarily because of its negative impact on the SID-IIs dummy's biofidelity. Previously published biofidelity ratings determined using the International Standards Organization (ISO) 9790 method showed the original SID-IIs has an overall biofidelity score of 7.0 on a 10.0 scale (Scherer et al., 1998). Recent tests conducted by OSRP member laboratories have shown the biofidelity score of SID-IIsFRG drops to 5.9. This decrease in overall biofidelity from an ISO 9790 classification of "good" to "fair" results primarily from a drop in thoracic and abdominal biofidelity, undoubtedly due to stiffening of the deflection response in the thoracic and abdominal ribs by the FRG system. This stiffening of the rib response was documented recently by researchers at Transport Canada in comparative full-vehicle crash tests with the original SID-IIs and SID-IIsFRG (Tylko and Dalmotas, 2004). The authors concluded that the original SID-IIs is durable despite the severe test conditions used in the study (IIHS MDB impacts) and that the FRG adversely affects dummy rib response. NHTSA appears to have made a compromise that makes this small female dummy less biofidelic to increase its durability in a contrived sled test.