January 18, 2004

Mr. Stephen R. Kratzke
Associate Administrator for Rulemaking
National Highway Traffic Safety Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

Re: Docket No. NHTSA-2004-18765; Frontal New Car Assessment Program (NCAP); Notice and Request for Comments

Dear Mr. Kratzke:

I appreciate the opportunity to respond to the National Highway Traffic Safety Administration (NHTSA) request for comments (RFC) concerning the future of the Frontal NCAP. Indeed, the prospect of meaningful change to NCAP is truly encouraging, particularly to improve the safety of small occupants in frontal crashes.

NHTSA SHOULD INCLUDE SMALL OCCUPANT DUMMIES IN NCAP TESTS

Recent sled testing illustrates dangerous discrepancy between belt "fit" versus performance.[1]

My research group recently conducted a series of frontal and oblique sled tests from 0 to 60 degrees, in 15 degree increments, on a rebound sled at velocities of approximately 35 kph (22 mph). Hybrid III 5th percentile female (H3-5F) and 6-year-old child (H3-6C) dummies were positioned in the right rear (far-side) outboard seats of a sled buck constructed from a post 1997 model full size SUV (Figure 1). The second row seat was initially fitted with an OEM adjustable upper belt anchorage and C-pillar mounted retractor. The third row restraint system included a fixed upper anchorage with an OEM roof-rail mounted retractor.

A second series of sled tests evaluated restraint countermeasures to injury-predictive dummy kinematics, which included retractor pretensioners and modifications to belt anchorage geometry. These countermeasures were also evaluated with a 95th percentile male dummy to evaluate whether countermeasures judged beneficial for small occupants would result in compromise to the largest male dummy kinematics and injury metrics.

FIGURE 1: Buck positioned at 30° (Test ACRD 103)

[1] Two manuscripts resulting from this study ("Small Occupant Dynamics in the Rear Seat: Influence of Impact Angle and Belt Restraint Design" and "Lap-Shoulder Belt Performance as a Function of Occupant Size") are pending final review of revisions and are tentatively scheduled for publication in 2005. I will share all test data with NHTSA upon request.

2100 THIRD AVE. NORTH, SUITE 410 BIRMINGHAM, ALABAMA 35203 T 205.326.6813 F 205.322.0766

Kinematic targets were mounted on the dummies' head, shoulder and pelvis. Test instrumentation included the following: lap and shoulder belt load transducers, triaxial accelerometers at the center of gravity of the head, triaxial accelerometers and a deflection gauge in the chest, and a six-axis force (and moment) transducer in the upper neck of the dummy. Tests were digitally recorded at 1000 frames per second using high speed digital video cameras placed around the test fixture. Cameras were set up on the left side of the buck for video analysis. In addition, pre- and post-test images were taken using still digital photography. Sensor signals were filtered according to SAE specifications.

The kinematic data was compared to the earlier work of Horsch[2], which reported that the shoulder belt retained the upper body of a 50th percentile male dummy for impact angles up to 45 degrees, and that for mid-size male dummies, "…significant kinetic energy was removed from the upper body before escape, even for full lateral deceleration." In contrast to Horsch, this study revealed that H3-6C and H3-5F dummies began to roll out of their shoulder belt at 15 and 30 degrees, respectively. (Figure 2, 3) Complete loss of torso support was seen at 45 degrees without significant kinetic energy dissipation. The H3-5F and H3-6C dummies "submarined", with lap belt loads exceeding known injury tolerance for the human abdomen in all sled tests with OEM rear belt restraint designs.

FIGURE 2: Pre- and Post-test belt positions for H3-5F (30 degrees)

Countermeasures were identified to significantly improve small occupant kinematics and injury metrics. A retractor pretensioner with 7 ms fire time prevented torso rollout of the H3-6C child dummy at impact angles up to and including 45 degrees. Elimination of submarining for the H3-5F, however, required significant modification of the OEM belt system's inboard buckle and anchorage geometry, even in the presence of a retractor pretensioner. A belt system incorporating a 23 degree buckle angle, coupled with a retractor pretensioner (7 ms fire time) eliminated both submarining and torso rollout in the H3-5F in the test environment. (Figure 4)

[2] Horsch, J.D. "Occupant Dynamics as a Function of Impact Angle and Belt Restraint," SAE 801310, 1980

FIGURE 3: Pre- and Post-Test H3-6C (30 degrees)

FIGURE 4: OEM Buckle (Allowed Submarining) vs. Modified Buckle Geometry (Prevented Submarining). The retro fitted buckle was attached solidly to the seat frame. The buckle could only be rotated a limited amount in the XZ plane.

Existing Federal Motor Vehicle Safety Standards (FMVSS) do not provide any design guidance with respect to dynamic performance of rear seat restraint systems. Even the front seat restraint systems have few dynamic performance requirements for other than 50th percentile male test dummies. Only the lap portion of rear seat belt restraints is required to "fit" occupants ranging in size from an average-size six-year-old child (H3-6C) to a 95th percentile male (H3-95M) test dummy. Fit is generally undefined, except for the "comfort and convenience" requirements specified in FMVSS 208 (S7.1.1), which applies to fifth percentile female (H3-5F) to H3-95M test dummies in the outboard seating positions. No requirements exist within the FMVSS to dynamically test for the safety and/or efficacy of rear seat lap-shoulder belts when used alone or in conjunction with aftermarket child safety seats or booster seats in any crash mode. Furthermore, no requirements exist within the FMVSS to dynamically test for the risk of catastrophic head injury against interior surfaces within a child's head strike zone (e.g. the top and back surfaces of the front occupant seat backs, the vertical portion of door window frames, belt line surfaces of passenger doors).

NHTSA states within the present RFC that "…the basic philosophy of NCAP … (is) to provide consumers with *meaningful comparative safety information for their purchase decisions* and to provide a *market incentive for manufacturers to build safer vehicles*." Existing safety standards do NOT provide consumers with meaningful dynamic test information concerning the safety of the rear seating compartments, particularly for small occupants. As a consequence, NHTSA is presently advising parents to restrain their children in areas of the vehicle that (1) have not been evaluated and certified as safe for adults or children through dynamic testing, and/or (2) have not been publicly subjected to the market pressures (incentives) to produce a verifiably safe vehicle for small occupants.

In reviewing the industry's response to this docket, and other dockets concerning the inclusion of small occupant dummies in FMVSS and NCAP, I am reminded of my Alabama (Republican) Senator Richard Shelby's rationale for his consistent opposition to tort reform legislation in Congress. He insists that he supports the Republican party's platform against "big government" intervention in the private sector; however, he is equally adamant that consumer rights be protected. Thus, he has always consistently voted for the rights of consumers to "regulate" industry through the judicial (tort) system in America. Applying similar logic to the present

discussion, if the auto industry opposes further mandatory federal regulation through FMVSS (i.e. "big government"), to ensure the safety of small occupants in their vehicles, then the only fair and reasonable alternative for consumers is to let the marketplace regulate conduct. In order for consumers to have an opportunity to fairly "regulate" the industry, the motoring public must be provided "meaningful comparative safety information for purchase decisions." That information can only be provided through NCAP testing and wide dissemination of the results.

To summarize, the sled test results provided in this submission are predictive of catastrophic injury to occupants ranging in size from ages 6-12 year old children (i.e. the H3-5F approximates a 50th percentile twelve-year-old child) in the 2nd and 3rd row seats of a very popular, large SUV, which is extensively marketed as a "family vehicle." Real world injuries to restrained back seat child occupants have been extensively reported in the literature and include catastrophic head and spinal injuries. (Agran, 1987; 1988; 1997; Anund, 2003; Bidez, 2001; Gotschall, 1998; Henderson, 1994; 1997; Howard, 2002; Klinich, 1993; Parenteau, 2003; Slavik, 1997) The auto industry simply must be regulated to protect small occupants by either the federal government through FMVSS or through the consumers' purchasing decisions, objectively informed by NCAP test data.

Specific Recommendations for Consideration

1. Incorporate a left offset frontal test with 5th percentile female Hybrid III dummies in the driver's seated position and the right front passenger position.

2. Include three Hybrid III child dummies in the rear seat of each vehicle

    a. 3-year-old dummy restrained in a child seat specifically recommended by the car company in their vehicle's owner's manual

        Every auto manufacturer should take responsibility for telling consumers which aftermarket seat(s) it certifies will perform safely in their respective vehicle.

    b. 6-year-old dummy restrained in the vehicle's lap-shoulder belt in the right outboard seat position

        I fully understand that "best practice" as defined by NHTSA and child advocacy groups states that this age (and anthropometry) child should be restrained in an aftermarket booster seat; however, the reality is that the vast majority of older children do NOT use such seats. Historical trends suggest that they will never do so in a meaningful way, irrespective of the amount of money allocated to public education programs. Without question, restraint technology currently exists to "rebalance" rear restraint systems to perform safely in a dynamic crash environment for children the size of Hybrid III 6-year-old dummies (50 lb; 25 inches sitting height). This recommendation, however, will require bold leadership on the part of NHTSA to act in the best interest of consumers.

    c. 10-year-old dummy restrained in the vehicle's lap-shoulder belt in the left outboard seat position

        The sitting height of this older child dummy should allow for testing of the padding of the driver's seat back, which is in the dummy's likely head strike zone.

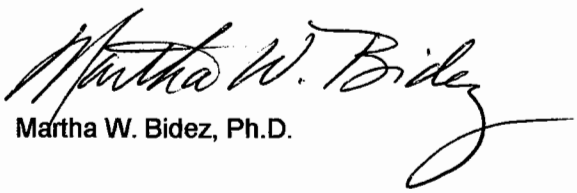
3. Replace N_{ij} with axial neck tension as the primary injury predictive criteria, particularly for the child dummies in the rear seat positions

4. Replace chest acceleration with chest displacement as the primary injury predictive criteria with lower threshold for small occupant dummies

5. Replace HIC 36 with HIC 15

Thank you for the opportunity to share my comments on this important subject.

Sincerely,



Martha W. Bidez, Ph.D.

REFERENCES

1. Agran, P.F. “Traumatic Injuries Among Children Using Lap Belts and Lap/Shoulder Belts in Motor Vehicle Collisions.” 31st Annual Proceedings of the AAAM; New Orleans, LA; September 28-30, 1987.
2. Agran, P.F. and Winn, D.G. “Injuries Among 4 to 9 year old Restrained Motor Vehicle Occupants by Seat Location and Crash Impact Site.” 32nd Annual Proceedings of the AAAM; Seattle, WA; September 12-14, pp. 39-51,1988.
3. Agran, Phyllis F.; Anderson, Craig L. and Winn, Diane G., “Restraint Use Among Children in Fatal Crashes,” Society of Automotive Engineers, Paper No. 973300, 1997.
4. Anund, Anna, et al, “Child safety in cars-Literature review,” Swedish National Road and Transportation Research Laboratories, Report 489A, 2003.
5. Bidez, M.W. and Syson, S.R. “Kinematics, Injury Mechanism and Design Considerations for Older Children in Adult Torso Belts.” SAE Paper No. 2001-01-0173.
6. Gotschall, CS, Better, AI, Bulas, D, Eichelberger, Bentz, F and Warner, M. “Injuries to Children Restrained in 2- and 3-Point Belts.” 42nd Annual Proceedings of the AAAM, October 5-7, 1998.
7. Henderson, M.; Brown, J. and Paine, M. ”Injuries to Restrained Children” Proceedings of the 38th Annual Meeting of the Association for the Advancement of Automotive Medicine; Lyon, France, pp. 75- 87, September 21-23, 1994.
8. Henderson, M.; Brown, J. and Griffiths, M. “Children in Adult Seat Belts and Child Harnesses.” Final Report, Federal Office of Road Safety, Department of Transport and Communications, Canberra, 1997.
9. Horsch, J.D. “Occupant Dynamics as a Function of Impact Angle and Belt Restraint,” SAE Paper No. 801310, 1980.
10. Klinich, K.D. and Burton, R.W. “Injury Patterns of Older Children in Automotive Accidents,” SAE 933082, 1993.
11. NHTSA; DOT Report HS 809 671, “Misuse of Child Restraints” by Decina and Lococo; January, 2004.
12. Parenteau, C. and Viano, D.C. “Field Data Analysis of Rear Occupant Injuries. Part II:Children, Toddlers and Infants.” SAE 2003-01-0154.
13. Slavik, DH: “Cervical Distraction Injuries to Children” SAE 973306, 1997.
14. Zellmer, H., Luhrs, S. and Bruggemann, K., “Optimized Restraint Systems for Rear Seat Passengers,” 15th ESV Conference, 98-S1-W-23, 1998.