

# INSURANCE INSTITUTE FOR HIGHWAY SAFETY

July 1, 2002

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

## **Revisions to FMVSS 213, Child Restraint Systems Docket No. NHTSA-02-11707**

Dear Dr. Runge:

In response to the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act, the National Highway Traffic Safety Administration (NHTSA) has proposed changes to Federal Motor Vehicle Safety Standard (FMVSS) 213, Child Restraint Systems. FMVSS 213 was last modified in the early 1980s and is outdated. The existing standard requires that child restraints meet certain specifications when subjected to frontal sled tests simulating a crash at 30 mph. The standard uses a standardized seat assembly, which is based on a bench seat in use in the 1970s; it does not use the most advanced child dummies available; and the performance criteria do not reflect the current state of biomechanics knowledge. Furthermore, the current standard applies only to child restraints recommended for children weighing up to 50 pounds, despite the fact that most belt-positioning booster seats are recommended by manufacturers for children weighing up to 80 pounds. The changes NHTSA is proposing address these and other less critical issues.

The proposed changes include revised specifications for the standard bench seat used in dynamic tests, improved test dummies that represent children of various sizes, and revised injury criteria to establish compliance with the performance requirements of the standard. NHTSA also proposes to modify the specification of the crash pulse in dynamic tests and requests comments on whether the current test severity is appropriate.

The Insurance Institute for Highway Safety supports the general aim of the proposed changes. However, we are concerned that the proposed standard does not address the primary concern about belt-positioning boosters; that is, the proposal does not include a means to assess whether booster seats provide a good fit of an adult belt with children of various ages and sizes to reduce abdominal loading.

### **Vehicle Belt Routing Assessment for Booster Seats**

Dynamic tests of belt-positioning boosters may help ensure that a booster design does not allow excessive forward movement of a child in a frontal crash (see problem with shoulder belt-adjusting guides

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below), but such tests cannot adequately evaluate the ability of the booster to improve belt fit and reduce the risks of abdominal loading. A lap belt should be routed low across a child's lap/upper thigh. This routing is to ensure that, in the event of a crash, the lap belt will stay low and not rise up into soft internal organs of the child's abdominal region. A recent evaluation of booster seat fit by Institute researchers (Insurance Institute for Highway Safety, 2001) showed that not all boosters provide good belt fit. Children differ in physique, vehicle seats and seat belt geometries vary considerably from vehicle to vehicle, and booster seats have varying features to address this. The result is that, while some seats clearly can improve fit, others do not route belts to achieve recommended lap belt fit.

There are additional concerns. In some cases seat belt guides on booster seats, designed to reposition shoulder belts appropriately, were found to introduce slack in the belt. A wiggly child could exacerbate this. Additional slack can be introduced as a child moves around, and some belt guides prevent the slack from being removed because the guides lock the belt in place. The concern is that a loose belt will allow a child to move farther forward in a crash or come out of the belt. A child's shoulders are much narrower than an adult's, and the shoulder belt can slip off the shoulder if it is not positioned snug against the chest.

Dynamic tests could address lap belt fit somewhat better if the test dummies were equipped with sensors to measure abdominal injury risk from improperly positioned lap belts. Even the more advanced Hybrid III dummies, which NHTSA proposes to use, are not equipped to measure penetration of the lap belt into the abdomen. In addition, current dummies like the Hybrid III 6 year-old cannot replicate some critical occupant kinematics because they have a rigid spine and a pelvis that is molded in a seating posture. Thus, the dummy may not submarine under even a poorly positioned lap belt. Presently, a booster seat could pass the dynamic test but still put a child at risk of abdominal injuries. Without more sophisticated dummies, it is imperative that the belt routing provided by a belt-positioning booster seat be regulated. A standard that fails to address belt fit is inadequate and probably will do little to improve the safety of restrained children in real-world crashes. Therefore, NHTSA should first focus on the issue of belt positioning, with dynamic testing to follow when better test procedures can be adequately defined.

#### **Updated Bench Seat**

The Institute supports the proposal to update the bench seat to be more representative of current production seats. An additional advantage is that this step would harmonize the standard with the

European standard. The bench seat used for dynamic testing of child restraints is based on the front bench seat of a 1974 Chevrolet Impala, and NHTSA's own study notes that it does not reflect the design of vehicle seats currently in production. Among the suggested revisions is an increase in the vehicle seat cushion angle (from 8 to 15 degrees) to make the seat more representative of vehicles in the fleet. One consequence of the current use of an outdated bench seat is that child restraints, which are designed to fit the test seat and achieve good dynamic test results, do not fit in many of the seats of modern vehicles. Institute researchers recently checked the fit of a popular convertible infant/toddler restraint (Cosco Triad) in 11 new car models equipped with LATCH connections. The restraint could be fitted at the correct recline angle (between 30 and 45 degrees) in the rear-facing position in only 3 of the tested vehicle models without using rolled towels or other articles to adjust the restraint's fit to the seat pan. Were the Cosco Triad designed to fit at the correct recline angle on the revised test seat, we estimate that it could be fitted properly in the rear-facing position in 9 of the 11 vehicle models without use of external props. Data from child restraint checkpoints suggests that as many as 30 percent of parents install rear-facing restraints at the wrong recline angle (Taft et al., 1999). The proposed change to the vehicle seat design should help alleviate this problem.

#### **More Severe Crash Pulse**

NHTSA requested comment on whether a more severe crash pulse should be developed for dynamic test requirements. The Institute sees no need to increase the severity of the current test crash pulse above 30 mph. An Institute review of NASS cases showed that child restraints designed to pass the current 30 mph sled test are providing very good protection to children in frontal crashes (Insurance Institute for Highway Safety, 2002). There was no indication, based on an analysis of injuries, crash description, and photos in these 10 frontal crashes that designing child restraints to withstand higher crash forces could have prevented or mitigated any of the serious or fatal injuries. Furthermore, in NHTSA's own sled tests simulating a 35 mph frontal crash using a Hybrid III 3-year-old dummy, there was little discernible difference among the 9 restraints tested compared with a 30 mph sled test.

#### **Improved Child Test Dummies**

NHTSA is proposing to use the CRABI 12-month-old and Hybrid III 3- and 6-year-old dummies in its child restraint testing. The current newborn dummy would continue to be used, but the CRABI 12-month-old will replace the 9-month-old dummy. Hybrid III versions of the 3- and 6-year-old dummies would replace the Hybrid II versions in current use. In addition, NHTSA proposes to use a weighted version of the

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Hybrid III 6-year-old dummy (to bring the weight from 52 to 62 pounds) to test child restraints recommended for children weighing more than 50 pounds. This is an interim measure until the Hybrid III 10-year-old dummy is available.

The Institute supports NHTSA's upgrade to the more current dummies, because they better reflect the morphology of the child populations they represent than the predecessor dummies and because the 12-month-old, 3-year-old, and 6-year-old dummies are equipped with sensors to measure forces on the head, neck, and chest (the 9-month-old dummy is not able to measure any forces, and the Hybrid II 3- and 6-year-old dummies only measure forces on the head and chest). The Institute is, however, concerned that the agency's proposal to use a heavier 6-year-old dummy will not achieve the intended aims because the dummy is too short to represent the tallest occupants for whom boosters are recommended. Sitting height is an important factor in testing booster seats because a poorly designed booster may permit too much head excursion for taller occupants. Weight is, at most, a secondary issue for these restraints because the vehicle belts, which are not subject to testing under this standard, restrain the inertia of booster seat occupants. Therefore, we see no reason to introduce a heavy 6-year-old dummy as an interim measure until the 10-year-old dummy is available.

#### **New or Revised Injury Criteria**

The Institute favors NHTSA's proposal to revise existing head and chest injury criteria because the proposed revisions are in line with current biomechanical interpretations of these measures. We also support the idea of protecting children restrained by child restraints from neck injuries. Although we support  $N_{ij}$  for use in FMVSS 208 where there is a clear relationship between serious and fatal neck injury and airbag deployment, the relationship between neck injury and  $N_{ij}$  is not as well established for children in child restraints. Furthermore, it is not clear how seats could be better designed to lower neck injury measures. Previous Institute research, conducted to evaluate the durability of child restraints (Meyerson and Lund, 2001), involved 30 mph frontal offset car-to-utility-vehicle crashes with instrumented child dummies (Hybrid III 3 year-old or CRABI 12 month-old) properly positioned in child restraints in the rear seats of the vehicles. Delta Vs were 34 mph for the car and 27 mph for the utility vehicle. Although the recorded head and chest measures were below proposed criteria in all tests,  $N_{ij}$  exceeded 1.0 in one of four tests with the 3-year-old dummy facing forward and in the one test with the 12-month-old dummy facing rearward. Inertial neck tensile force was the main contributor to  $N_{ij}$  in all tests. Although NHTSA proposes to exclude neck axial force as an individual threshold, it is likely some child seats may exceed  $N_{ij}$  because it is calculated using these axial

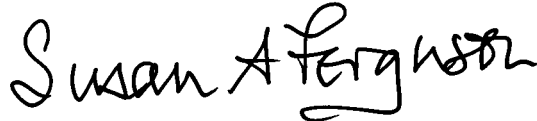
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forces. The worrisome aspect of these results is that studies of real-world crashes indicate neck injuries caused by inertial forces appear to be rare (Henderson et al., 1994; Huelke et al., 1992). More research is needed to quantify the incidence of neck injury among children in child restraints in real-world crashes and to establish the relationship between forces experienced in a crash and how this relates to neck injury.

### **Conclusion**

Child seats already are doing a very good job of protecting children in frontal crashes, and the proposed changes to the standard will go a small way to reducing injuries and deaths of children who ride in motor vehicles. Improving the structural integrity of vehicles and reducing gross misuse of child seats could achieve more. The Institute welcomes NHTSA's efforts to improve and update FMVSS 213. However, the current proposal lacks an important component -- a test of belt fit for booster seats currently on the market. A standard that fails to address belt fit is inadequate and probably will do little to significantly improve the safety of restrained children in real-world crashes.

Sincerely,

A handwritten signature in black ink that reads "Susan A. Ferguson". The signature is written in a cursive, flowing style.

Susan A. Ferguson, Ph.D.  
Senior Vice President, Research

cc: Docket Clerk, Docket No. NHTSA-02-11707

### **References**

Henderson, M.; Brown, J.; and Paine, M. 1995. Injuries to restrained children. Proceedings of the 38th Annual Conference of the Association for the Advancement of Automotive Medicine, 75-87. Del Plaines, IL: Association for the Advancement of Automotive Medicine.

Huelke, D.F.; Mackay, G. M.; Morris, A.; and Bradford, M. 1992. Car crashes and non-head impact cervical spine injuries in infants and children. SAE Technical Paper Series 920562. Warrendale, PA: Society of Automotive Engineers.

Insurance Institute for Highway Safety. 2001. Comment to the National Highway Traffic Safety Administration concerning the use and effectiveness of booster seats. Docket Document No. NHTSA 2001-10359-

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10, September 27, 2000. Washington, DC: U.S. Department of Transportation.

Insurance Institute for Highway Safety. 2002. Comment to the National Highway Traffic Safety Administration concerning safety rating program for child restraint systems. Docket Document No. NHTSA 2001-10053-42, January 7, 2000. Washington, DC: U.S. Department of Transportation.

Meyerson, S.L. and Lund, A.K. 2001. Child restraint durability in high-speed crashes. SAE Technical Paper Series 2001-01-0123. Warrendale, PA: Society of Automotive Engineers.

Taft, C.H.; Mickalide, A.D.; Taft, A.R. 1999. Child passengers at risk in America: a national study of car seat misuse. Washington, DC: National SAFE KIDS Campaign.