Statement before the Transportation Subcommittee, U.S. House of Representatives Appropriations Committee

Airbag test requirements under proposed new rule

Brian O'Neill

February 10, 2000

INSURANCE INSTITUTE FOR HIGHWAY SAFETY

1005 N. GLEBE RD. ARLINGTON, VA 22201-4751
PHONE 703/247-1500 FAX 703/247-1678
website http://www.highwaysafety.org

The Insurance Institute for Highway Safety is a nonprofit research and communications organization that identifies ways to reduce motor vehicle crashes and crash losses. I am the Institute's president, and I am here to comment on aspects of the National Highway Traffic Safety Administration's (NHTSA) Supplemental Notice of Proposed Rulemaking for Federal Motor Vehicle Safety Standard (FMVSS) 208. This proposal seeks to minimize the risks from inflating airbags and to upgrade protection in high-speed frontal crashes.

NHTSA's proposal includes a series of tests that will greatly increase the regulatory testing required of auto manufacturers. Still, manufacturers and others who have commented to NHTSA support almost all of the provisions in the proposed rule, including the addition of dummies representing small females and children in a wide variety of tests to minimize airbag risks while ensuring protection in crashes at higher speeds. Meeting these requirements will not be trivial and certainly will make a difference in how airbags are designed. The result will be less risk from inflating airbags while preserving their well-documented benefits.

Crash test alternatives

However, one proposed requirement has stirred disagreement — the possible mandatory return to 30 mph rigid-barrier crash tests to assess unbelted occupant protection. Many constituencies have grave concerns about the mandatory reinstatement of these tests, which now are optional, because this likely would mean the airbag inflator power levels in some vehicles would return to the levels that have caused deaths and injuries to out-of-position occupants.

NHTSA amended FMVSS 208 in March 1997 to allow manufacturers to use 30 mph sled tests for unbelted testing as an alternative to 30 mph rigid-barrier tests. This alternative, which has lower decelerations than 30 mph rigid-barrier tests, was allowed because of the realization that many airbags designed to meet 30 mph barrier test requirements were too aggressive and, as a result, had caused some deaths and injuries. The added advantage of sled tests compared with full-scale vehicle crash tests was that they allowed manufacturers to install less aggressive airbags on a faster schedule.

Although NHTSA allowed the sled test option, the agency has expressed concern on several occasions that airbags designed to meet this test could provide less protection to unbelted occupants in high-speed crashes. NHTSA predicted lives could be lost because sled tests are less severe than 30 mph rigid-barrier tests. Agency estimates of how many lives could be lost vary enormously — 328 to 1,182 lives (December 1996), 46 to 409 lives (February 1997), and 335 to 405 lives (August 1998).

Despite these estimates, NHTSA has not documented a single death due to inadequate airbag performance during the two years the sled test option has been allowed and many vehicles have been equipped with less aggressive airbags. Plus the agency's Preliminary Economic Assessment that accompanies the Supplemental Notice of Proposed Rulemaking reports no reduction in effectiveness for either belted or unbelted occupants in 1998 models, certified with sled tests, compared with 1996-97 models certified with 30 mph barrier tests. Yet NHTSA still is adamant about eliminating the sled test option and going back to full-scale crash tests.

NHTSA has proposed three crash test alternatives to assess airbag protection in crashes at higher speeds — rigid-barrier tests conducted at 30 mph with unbelted and belted dummies (this option is currently included in FMVSS 208); rigid-barrier tests conducted at 25 mph with unbelted dummies and 35 mph with belted dummies; or offset deformable barrier tests at 30 or 35 mph with unbelted dummies and rigid-barrier tests at 30 mph with belted dummies. Not everyone agrees about which test alternative NHTSA should adopt, but the majority including domestic and international auto manufacturers, airbag suppliers, the Insurance Institute for Highway Safety, National Transportation Safety Board, National Safety Council, American Automobile Association, and National Association of Governors' Highway Safety Representatives strongly oppose the first option. Most support the second option — rigid-barrier tests at 25 mph (unbelted) and 35 mph (belted).

Support for this option is based primarily on the fact that, for most vehicles, a 25 mph rigid-barrier test produces crash decelerations only slightly higher than the 30 mph sled test. Therefore, barrier tests with unbelted dummies at 25 mph should not force a return to overly aggressive airbag designs. In addition, increasing the speed of full-front barrier tests for belted occupants from 30 to 35 mph can be expected to improve frontal crash protection for belted occupants in many vehicles.

Others including the Center for Auto Safety, Public Citizen, Consumers Union, and Parents for Safer Airbags support 30 mph barrier tests with unbelted dummies. These groups believe protection for unbelted occupants in high-speed crashes would be lessened if 25 mph tests with unbelted dummies were allowed. In some cases, support for 30 mph tests with unbelted dummies follows from the mistaken belief that higher test speeds guarantee protection in real-world crashes at higher speeds. But this is not true. It reflects an overly simplistic view that does not take into account the complex physics and biomechanics of car crashes. Unfortunately, some NHTSA analyses lend credence to this view by concluding that 25 mph tests with unbelted dummies could lead to inadequate airbag protection for some unbelted occupants in high-severity frontal crashes. The rest of my testimony explains how the NHTSA analyses used to justify these conclusions are based on unsubstantiated hypotheses and ignore contrary evidence from real-world crashes.

In the Preliminary Economic Assessment that accompanies NHTSA's Supplemental Notice of Proposed Rulemaking, the agency attempted to quantify the potential benefits of airbags if they were designed to meet the agency's requirements in rigid-barrier tests with unbelted dummies at 25 mph instead of 30 mph. The agency's latest analysis claims "214 to 397 lives involved in high-speed crashes would not be saved if airbags were designed to meet the 25 mph rigid-barrier and oblique unbelted tests." These estimates are based on two approaches. The first used the National Automotive Sampling System/Crashworthiness Data System (NASS/CDS), which contains data from detailed investigations of a sample of all crashes in the United States involving towed vehicles. The second approach estimated additional deaths based on injury measures recorded on unbelted dummies in rigid-barrier crash tests at 25 and 30 mph. An examination of these approaches reveals multiple flaws that render the estimates worthless.

NASS fatality effectiveness analysis

NHTSA used NASS data to estimate the effectiveness of airbags in preventing deaths among unbelted occupants in frontal crashes. Separate effectiveness estimates were computed for different crash severity ranges measured by crash speed differential, referred to as delta V. These effectiveness estimates then were used to estimate the potential number of unbelted occupants who would be saved in each crash severity range if all cars had airbags. There are several flaws in the methodology used to produce these estimates (see appendix), but the fatal flaw that renders useless NHTSA's final conclusions involves how the agency interpreted the effectiveness estimates for different crash severity ranges.

Noting that estimated airbag effectiveness is greatest for crash severities about 5 mph below 30 mph and less for crash severities above 30 mph, NHTSA assumed these differences are entirely due to airbag performance — an invalid assumption. Detailed examination of individual NASS cases provides convincing evidence that the reduced effectiveness estimates for higher crash severities have nothing to do with inadequate airbag performance. Instead, they are caused by intrusion of vehicle structure into occupant compartments, by occupant ejection from vehicles, or by the airbags themselves. NASS data show intrusion is much more likely to occur in crashes at higher severities, and in crashes with massive intrusion no airbag design can provide effective protection. The esti-

mated delta V of the fatal crash shown top left, for example, was 47 mph — and it is obvious that with so much intrusion airbag performance was not a factor in the fatal injury to the unbelted occupant. People without belts also are more likely to be ejected in crashes at higher severities. When this occurs, airbag performance again is irrelevant to injury outcome. For example, in the crash shown below left the unbelted driver was ejected and killed. The delta V of this impact was 36 mph. Finally, unbelted occupants in high-severity crashes are more likely to be out of position — thus more likely to be killed by inflating airbags — because maneuvers before impact will be more violent.

Ignoring evidence that, as crash severity increases, fatality risk increasingly is influenced by intrusion and ejection, NHTSA instead assumed the different effectiveness estimates are entirely due to airbag performance. In turn, this led the agency to assume that airbags designed to meet requirements in 25 mph barrier tests would have reduced effectiveness values in crashes with delta Vs higher than 20 mph. To do this, NHTSA simply shifted all the effectiveness estimates down by 5 mph (see table on the next page). Thus, NHTSA assumed its calculated effectiveness estimate of 0.154 for crashes with delta Vs of 31 mph and greater would apply to crashes of 26 mph and greater for airbags designed to meet 25 mph barrier tests. All other effectiveness estimates were shifted down by 5 mph. Based on this wholly unjustified shifting, NHTSA concluded that an additional 214 unbelted occupants would die if airbags were designed to 25 mph barrier tests (see table on the next page).

The final estimate of 214 lives lost follows entirely from NHTSA's assumption that the only factor affecting the airbag effectiveness estimates in the different crash severity ranges is airbag performance. This ignores the obvious fact that many high-speed deaths involving intrusion and/or ejection cannot

NHTSA's assessment of lives saved by airbags, using NASS data

	Delta V (mph)	Airbag effectiveness estimates	Unbelted population	Lives saved	
Airbags	0-20	0.145	1,919	278	
designed to	21-25	0.305	2,069	631	
30 mph rigid-	26-30	0.213	2,468	526	} 1,467
barrier test	31+	0.154	6,113	941	
Effectiveness estimates from 1993-98 NASS/CDS			12,569		
Airbags	0-15	0.145	1,159	168	} 400
designed to	16-20	0.305	760	232	
25 mph rigid-	21-25	0.213	2,069	441	
barrier test	26+	0.154	8,581	1,321	
Effectiveness reduced by 5 mph			12,569		

NHTSA's estimates of lives saved by airbags designed to 30 versus 25 mph barrier tests

Delta V (mph)	30 mph	25 mph	Difference
0-20	278	400	+122
21-25	631	441	-190
26+	1,467	1,321	-146
All	2,376	2,162	-214

be prevented no matter how good the airbag design. At the same time, there is evidence that airbags certified at 25 mph can be less aggressive, actually reducing the likelihood of some fatal airbag injuries at all crash severities.

Those who support higher crash test speeds need to recognize that restraint system performance — whether safety belts plus airbags or airbags alone — is only one aspect of an occupant's fatal crash risk. Intrusion and ejection as well as airbag aggressivity are important, and the first two become even more important as crash severities increase. It therefore makes no sense to demand that airbags protect people in high-severity crashes if the deaths in such crashes could not be avoided by any level of airbag performance. In this respect, it is important to note that rigid-barrier tests, even conducted at 35 mph, are not ideal to address the issues of intrusion or ejection. Addressing these requires other crash modes.

Crash test analyses

Also flawed is the second approach NHTSA used to estimate the differential benefits to unbelted occupants from airbags designed to the two different barrier test speeds (25 versus 30 mph). The agency used dummy head and chest injury measures from 25 and 30 mph tests of two 1999 Dodge Intrepids and two 1999 Toyota Tacomas with unbelted dummies to compute injury ratios. NHTSA then assumed these injury ratios would apply to all vehicles in the fleet. A second assumption was that airbags designed to the lower crash test speed would produce the same injury measures in a 25 mph rigid-barrier test as airbags designed to the higher test speed would produce at 30 mph. Taking results of 30 mph crash tests of pre-1998 model vehicles with airbags designed to the higher crash test speed, NHTSA then used the injury ratios to estimate expected injury measures if airbags were designed to meet the lower crash test speed. If an airbag designed to the higher crash test speed had a head injury criterion (HIC) of 400 at 30 mph, NHTSA assumed the same vehicle with airbags designed to meet the lower crash test speed would have a HIC of 400 in a 25 mph test. Then the agency used a HIC ratio of 2.0, for example, to further estimate that the same vehicle would produce a HIC of 800 in a 30 mph test. Similar extrapolations were applied to chest acceleration measures.

NHTSA then estimated the additional lives lost by comparing the actual and hypothetical HICs and chest accelerations with injury risk curves. The result was an estimate of the deaths — 397 — that could be lost by allowing barrier tests with unbelted dummies at 25 mph instead of 30 mph.

The assumptions used to obtain the hypothetical injury measures are questionable, to say the least, but the fundamental problem with this analysis is the absurdity of making fleet-wide projections based on dummy head and chest injury ratios from only two models. Estimates of additional lives lost derived from crash tests with unbelted dummies are essentially worthless because the tests themselves are inadequate surrogates for unbelted people in real-world crashes. In the real world, the positions of unbelted people during high-speed crashes are unpredictable. Such crashes often are preceded by violent maneuvers so that unbelted people are out of position by the time their airbags begin inflating. The protection offered by airbags in such cases is unpredictable, and the bags themselves may cause harm. In contrast, unbelted dummies in crash tests always are sitting back in the seat where airbags can offer protection, so protecting unbelted dummies in crash tests simply is not the same as protecting unbelted people in real-world crashes.

Conclusions

NHTSA's analyses do not provide one shred of convincing evidence that airbags designed to 30 mph barrier tests will provide more protection to unbelted people than airbags designed to 25 mph tests. On the other hand, evidence is convincing that airbags designed to 30 mph tests will do more harm to out-of-position occupants. NHTSA's fundamentally flawed analyses ignore the fact that the agency has not provided a single documented case of a real-world frontal crash in which an occupant died because of insufficient protection offered by an airbag. This conclusion is true for airbags designed to sled tests and for airbags designed to 30 mph barrier tests. Yet if the reduced effectiveness in crashes at higher severities were due to inadequate airbag performance, as NHTSA asserts, then such cases should have occurred frequently by now. The question for NHTSA is, where are they?

Those who support rigid-barrier crash testing at higher and higher speeds need to understand that even the most advanced airbag technology cannot eliminate high-speed crash deaths when there is major intrusion into the occupant's space. Nor can such technology prevent unbelted occupants from dying when they are ejected from their vehicles. These are the issues that should be addressed to improve protection in high-speed crashes — not the simple-minded idea that higher rigid-barrier crash test speeds for airbags must be good.

Appendix: NASS analysis

To estimate the differential benefits of 25 versus 30 mph test procedures, NHTSA first calculated effectiveness estimates for airbags in frontal crashes at different delta Vs. Using nationally weighted results from 1993-98 NASS/CDS, front outboard passenger vehicle occupants age 13 or older with serious (AIS 3+) and fatal injuries were classified according to whether the principal impact to the vehicle was frontal or nonfrontal, whether an airbag was available, and by delta V (0-20 mph, 21-25 mph, 26-30 mph, 31+ mph). That is, serious and fatal injuries in this population were used to represent fatal injuries.

For each category of delta V, effectiveness estimates were derived by comparing the odds of airbag availability in relevant frontal crashes to the odds of airbag availability in relevant nonfrontal crashes. The rationale is that if airbags reduce deaths in the frontal crashes in which they are designed to deploy, the relative frequency of deaths in frontal versus nonfrontal crashes should be lower in vehicles with airbags than in vehicles without them. For example, for delta Vs 0-20 mph, an estimated 21,035 occupants were in frontal crashes with airbags, 70,167 were in frontal crashes without airbags, 14,296 were in nonfrontal crashes with airbags, and 31,528 were in nonfrontal crashes without airbags. The effectiveness of airbags at preventing serious or fatal injuries at delta Vs of 20 mph or less is

$$1 - [(21{,}035)/(70{,}167)]/[(14{,}296)/(31{,}528)] = 33.9 \text{ percent.}$$

The overall effectiveness value derived using this approach with NASS/CDS data was more than twice as high as that derived using the Fatality Analysis Reporting System, a database that includes a census of all fatal crashes in the United States. To adjust the NASS/CDS effectiveness estimates to account for fatalities only (NASS analyses used serious and fatal injuries because sample sizes were too small to use fatals only), each effectiveness estimate was multiplied by a scale factor (approximately 0.43) based on the ratio of FARS-estimated effectiveness to NASS-estimated effectiveness.

Effectiveness estimates were multiplied by corresponding estimates of potential unrestrained fatalities to obtain estimates of lives saved in each delta V category. Finally, it was assumed that airbags designed to meet a barrier test at 5 mph slower would have effectiveness values equivalent to those designed to the 30 mph test but at delta Vs 5 mph slower. For example, reductions of 14.5 percent in occupant fatalities were estimated at delta Vs of 0-20 mph for vehicles with airbags designed to the 30 mph barrier test. For vehicles with airbags designed to the 25 mph test, it was assumed that the same effectiveness applies only to speeds between 0 and 15 mph.

NHTSA's assessment of lives saved by airbags, using NASS data

	Delta V (mph)	Airbag effectiveness estimates	Unbelted population	Lives saved	
Airbags designed to 30 mph rigid-barrier test	0-20	0.145	1,919	278	
	21-25	0.305	2,069	631	
	26-30	0.213	2,468	526	} 1,467
	31+	0.154	6,113	941	
Effectiveness estimates from 1993-98 NASS/CDS			12,569		
Airbags designed to 25 mph rigid-barrier test	0-15	0.145	1,159	168	} 400
	16-20	0.305	760	232	
	21-25	0.213	2,069	441	
	26+	0.154	8,581	1,321	
Effectiveness reduced by 5 mph			12,569		

NHTSA's estimates of lives saved by airbags designed to 30 versus 25 mph barrier tests

Delta V (mph)	30 mph	25 mph	Difference
0-20	278	400	+122
21-25	631	441	-190
26+	1,467	1,321	-146
All	2,376	2,162	-214

Adding all the estimates together, airbags designed to 25 mph tests would save 214 fewer lives annually than airbags designed to 30 mph tests (2,376 – 2,162).

This analysis depends on a number of dubious assumptions:

1. It is assumed that the relationship between fatal injury effectiveness and delta V is completely determined by airbag performance. Therefore, an airbag change would shift the scale of the relationship. This ignores the fact that many deaths in high-speed crashes are due to intrusion or ejection. Such

deaths cannot be prevented by any airbag technology. This is why airbag effectiveness declines at higher speeds.

2. A number of studies have shown that occupants are being killed by airbags in crashes at high as well as low severities. It can be expected that less powerful airbags resulting from 25 mph barrier tests would result in fewer such deaths. But NHTSA did not adjust effectiveness estimates to account for these reductions in airbag-related deaths.

3. Because delta V cannot be calculated for all crashes, only those cases for which it is available are included in the NHTSA analysis. This assumes that overall effectiveness would be no different for crashes in which delta Vs are missing. As many as 34 percent of all frontal impacts and 60 percent of nonfrontal impacts in the NASS database do not have delta Vs. When overall airbag effectiveness is computed using all crashes, including those without delta Vs, the effectiveness is about 40 percent less than when using crashes with available delta Vs.

4. The effectiveness estimates are initially derived using injuries and fatalities. Then the estimates are scaled to account for fatalities only. This assumes the relationship between fatal injury effectiveness and delta V is the same as the relationship between serious injury effectiveness and delta V. However, there is no evidence that serious and fatal injury effectiveness follow the same pattern with delta V.

5. Because there are few fatalities in NASS/CDS, crashes in which occupants sustained serious to fatal injuries also are used to increase the sample size. Included are all serious injuries including those to the upper and lower extremities — injuries that according to NHTSA analyses are not mitigated by airbag deployment (4th Report to Congress).

6. According to NHTSA, airbags designed to the 25 mph barrier test would be expected to save 400 lives in crashes at 20 mph or slower, compared with only 278 lives for airbags designed to the 30 mph test. However, the agency provides no explanation why 25 mph airbags would be more effective than 30 mph airbags at these low speeds. Although real-world evidence would suggest that less powerful airbags are killing fewer people in low-severity crashes, nothing in the agency's assumptions factor this in.

Brian O'Neill

Mr. O'Neill is president of the Insurance Institute for Highway Safety, a nonprofit research and communications organization dedicated to reducing the losses resulting from motor vehicle crashes. The Institute is funded by automobile insurers.

Federal Funding Disclosure

Pursuant to the requirements of rule XI, clause 2(g)(4) of the Rules of the House of Representatives, the Insurance Institute for Highway Safety states that it does not receive any federal grants or contracts.