49 CFR Parts 571 and 598
[Docket No. NHTSA-2004-17694]
RIN 2127--AJ10

General Comments

NHTSA seems to assess test conditions in terms of their effect upon dummy dynamics and safety restraint design without any regard for the possible effect upon crash sensing. It is just assumed that the crash will be sensed in an appropriate time for a wide array of test conditions even when only a couple of highly specific tests are conducted. This assumption is untrue for many vehicle crash-sensing systems, as demonstrated by NHTSA testing. For every test condition under possible revision, NHTSA should consider the sensing implications. In the quest to obtain excellent "star-ratings" and low head injury criteria (HIC) values, sensor positioning, sensing technology, the arrangement and design of structural door elements, and the crash discrimination algorithms are often narrowly optimized to specifically enhance the response of the sensing system to the required tests. Unfortunately, many ways in which this can be easily and cheaply achieved will result in vehicles that have quite poor crash sensing response (late or no deployment) if the impact location or incident angle is changed by only a small amount (less than 15 deg and less than 20 cm). This results in a consumer misinformation campaign as NHTSA awards some vehicles 5-stars for their excellent performance during the standard test, while in the real world the restraints may deploy too late or not at all during similar crashes at very slightly different angles/impact positions. I would rather drive a vehicle that received a lower "star-rating" based upon a single test condition that has good sensing/protection for a variety of crash conditions than to have "5-star" vehicle that whose sensing/restraints perform poorly outside of a narrow band of crash conditions. As NHTSA is aware, inflatable head curtains are the most likely response of auto manufacturers to meet the HIC standards in these proposed new rules. These restraints can significantly improve occupant safety during a wide range of side impacts if they are deployed in time. The best-designed restraint is useless if it deploys 20 milliseconds after the occupant's head has struck the pole. NHTSA must somehow encourage the automakers to design total system safety solutions that provide broad crash location and incident angle coverage rather than rewarding them for coverage that is narrowly optimized for a few narrowly specified crash conditions. The revised rules and test procedures should be strengthened to ensure that if the vehicle relies upon a deployable restraint (e.g. head curtain) to meet the new HIC performance specified in these rules, then the sensing system that deploys that restraint must be capable of sensing the crash during a reasonable time for some real world range of incident angles and incident impact locations. Vehicle safety systems can be reasonably designed to work well under a broad range of real world conditions, but this will not necessarily be the result if the vehicle is not tested under some range of conditions.

Second Row Testing

While it is likely that many vehicle manufacturer's will implement rear seat head protection (air curtain), rear seat occupants may not be afforded similar head protection because many likely sensing arrangements, especially with one sensor per vehicle side, will not be capable of sensing a variety of rear door impacts. The restraints simply may not deploy for a wide variety of rear door impacts, causing potentially severe injuries to the rear seat occupants and moderate injuries to the supposedly protected front seat occupant. Parents are advised by NHTSA that the rear seat is the best place for their children to sit for their safety and protection (based primarily upon frontal crash scenarios). However, NHTSA proposes to neglect their safety for side impact crashes, wrongfully assuming that they will benefit from front row protection in a variety of crashes. Just because more miles are driven without rear seat occupants, leading to fewer rear seat deaths, does not mean that rear seat occupants should be exposed to a higher level of risk of death/serious injury simply because the safety sensing and restraints are not properly designed to provide them the same level of protection as a front seat occupant. Vehicle manufacturers often tailor their sensing, restraints, and mechanical safety structures to perform well on standardized safety tests rather than to uniformly protect all occupants from a wide range of likely real world crash scenarios. This will inevitably lead to significantly reduced side impact protection for rear seat occupants in many vehicles for many types of real world side impact crashes. Because children more commonly sit in the rear seats, this amounts to discriminating against the safety of this country's children in side impact crashes. NHTSA should require an identical pole test for the second row occupant.

Pole Test Speed

A pole speed of 32 km/h (20 mph) is clearly more appropriate than 29 km/h. The higher speed pole may require some combination of slightly better structural enhancements, sensing enhancements, and/or restraint enhancements. These designs do not place an undue burden upon vehicle manufacturers but simply provide a higher margin of safety for occupants. NHTSA should only consider a pole test speed of 32 km/h or higher.

Pole Test Angle

It should be the goal to provide protection to the occupants during pole impacts that occur at angles incident to the vehicle throughout the range of angles that commonly occur in real world crashes that lead to significant injury/death. NHTSA has observed the results obtained from the current application of sensing technologies by vehicle manufacturers given the current 201 pole testing requirements. Multiple vehicle manufacturers have selected technologies and applied them in such tailored ways so that they will perform well for the standard test, but likely may not sense the crash if the impact location and or angle is changed by a very small amount. For instance, if one compares the current production accelerometer (crash sensor) signals for 90 deg and 75 deg poles for a given vehicle one will find that the signal magnitudes may vary by an order of magnitude. While this result seems unlikely, vehicle manufacturer have and may continue to design the restraint sensing system to perform well on the prescribed test at the expensive of good general sensing performance. Simply changing the impact angle from 90deg to 75deg will likely lead to mechanical sensing arrangements that do only respond well to a narrow band of angles in a narrow region of incident locations. In order to prevent vehicle manufacturers from designing their sensing system (and restraints) to essentially only meet the required test, the test should ideally be conducted, for example, at 50 deg, 60 deg, 70 deg, and 80 deg with the seat track at the forward, middle, and rearward positions for all angles. However, this testing requirement (12 tests total) might be considered burdensome and expensive. One alternative to consider would be to write the standard so that each individual test will be conducted by NHTSA at a randomly chosen angle between 50 and 90 degrees where the actual test angle is chosen from a weighted distribution of actual principal direction of force (PDOF) crash angles. The most likely test angle would then be 60 deg, but the sensing and protection system will need to be designed to adequately perform (sense and protect) over a reasonable range of angles. I realize that the preceding recommendation will probably not be considered feasible, so I will offer a more reasonable alternative below.

A 75 deg pole test is a clear improvement over a 90 deg pole test in terms of real world applicability and in terms of occupant protection. However, choosing any single test angle may lead to the design of restraints that perform poorly for other angles and for sensing designs that **may not detect the crash at all** for other angles. **Since NHTSA has demonstrated that the current restraint sensing systems sometimes do not deploy when you change the incident angle by 15 degrees (from 90 to 75 deg), why does NHTSA think that changing the testing angle to 75 degrees will ensure that the sensing system will detect the crash in a timely manner the when the incident angle changes yet another 15 degrees (from 75 deg to the most common real world angle of 60 deg)?** More than one incident test angle is almost required given the evidence that two angles separated by only 15 degrees can produce rapid sensing and restraint deployment in one case and no restraint deployment in the other case. I would argue that NHTSA should retain the current 90 deg pole test and add the 75 deg pole test as a new requirement. Also, if a 75 deg pole test is chosen as the primary test to assess HIC performance, then I strongly suggest that vehicle manufacturer should demonstrate that any safety system (sensing & restraints) that are used to show compliance with the HIC standard will sense the crash deploy within a reasonable time for a 60 deg pole impact test. For example, the vehicle manufacturer could be required to demonstrate that its side impact sensing system will properly sense the crash for a 60 deg pole no later than about 1.3 times the deployment time achieved during a 75 deg pole test. The example 1.3 timing factor could be based upon computer modeling or other estimates of relative occupant gap closures during this event for a typical vehicle. Such a 60 deg test requirement would not relate to repeatable dummy dynamics or HIC repeatability (a dummy would not even be needed in the vehicle), but would demonstrate some reasonable level of real world sensing robustness over a reasonable range of incident angles. If some such requirement is not added to the proposed rules, then I predict that there will be a significant number of side impact accidents with poles and with other vehicles where the incident angle is near 60 degrees and where the occupant will suffer severe injuries because the restraints did not deploy or deployed too late to provide a safety benefit. It will be a great shame to install these wonderfully designed airbags and expensive sensing systems and yet have them not be designed to respond during the most common real world crash angles that lead to significant injury/death. We should not wait until after the inevitable lawsuits and consumer outrage that will result when many individuals die during side impact events and the restraints do not deploy to ensure that these systems have some reasonable level of robustness. NHTSA should drive crash sensing robustness rather than wait for the lawyers to force this issue. Unfortunately, many automakers will not even perform significant variable crash testing outside of the federally specified tests for fear that they will find a deficiency that can be used against them in possible future litigation. Some automakers sometimes prefer to be ignorant of the probable shortcomings of their safety systems rather than discover an engineering issue that may require additional expense to achieve a solution.

Occupant Seating Test Positions

From a sensing and restraint design standpoint it is clear that multiple seating positions are desirable and that the 214 seat position standard will create more robust safety systems than the 201 standard. Ideally, one should test with the seating position fully forward, mid-track, and fully rearward to ensure the widest restraint coverage and the most robust sensing technique. If only two seating positions can be chosen, then one should clearly select fully forward (5^{th} percentile female) and either a mid-track position (as in the 214 standard) or fully rearward position. Mid-track is probably the position most commonly found in the real world for most vehicles. Compared with a fully rearward track position, the mid-track position is probably a more vulnerable one for the occupant because it has less protection from the B-pillar structure. However, testing at the fully rearward position might require a wider-region coverage restraint design. Fully rearward seat track position testing will also provide a greater challenge for the sensing system because the impact location is changed more greatly from the fully forward position. This change in impact location usually makes it more difficult to locate a single point-sensor (e.g. accelerometer) to perform well for two or three impact locations. Using such different impact test locations may drive the sensing system to use distributed sensing techniques (e.g. pressure) or two or more point-sensors per vehicle side to achieve broad region coverage and acceptable deployment times. As with the incident test angle the sensors are often positioned to best detect the crash at the tested impact location. It is likely that, for some vehicles, moving the current 90 deg pole impact location forward or aft on the vehicle door by less than 20 cm could result in greatly delayed or non-deployment of restraints. Performing the test for three widely different impact locations will greatly enhance the sensing system performance over a range of real world crash conditions where the incident impact location will vary. NHTSA should consider the potential sensing benefit of adding a fully rearward track position seating test position to the test requirements.