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49 CFR Part 571

Federal Motor Vehicle Safety Standards; Head Restraints; Proposed Rule

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Part 571

[Docket No. NHTSA–2000–8570]

RIN 2127–AH09

Federal Motor Vehicle Safety Standards; Head Restraints

AGENCY: National Highway Traffic Safety Administration (NHTSA), DOT.

ACTION: Notice of proposed rulemaking.

SUMMARY: Consistent with this agency's policy of seeking to adopt those regulatory requirements that produce the highest benefits at reasonable costs, this document proposes to upgrade the standard for head restraints for passenger cars and for light multipurpose vehicles, trucks and buses. The proposal would establish higher minimum height requirements for head restraints, and add a requirement limiting backset, *i.e.*, the distance between a person's head and his or her head restraint. The proposal would also extend the requirement for head restraints to rear outboard designated seating positions; establish new strength requirements for head restraints; and place limits on the size of gaps and openings in head restraints. In addition, it would modify the dynamic compliance test and amend test procedures. The proposal would harmonize the standard with the counterpart regulation of the Economic Commission for Europe (ECE) to an extent, but would set different requirements for head restraint width and gap measurement for adjustable restraints. Further, it would add two requirements not found in the ECE regulation, *i.e.*, one for backset and one for adjustment retention locks. The goal of these proposed changes is to improve the protection that head restraints provide in rear-end collisions.

This document also proposes that before compliance with the upgraded requirements becomes mandatory on the first September 1, three years following publication of the final rule, the manufacturers could chose to comply with any of three sets of requirements: the existing requirements of Standard 202, the ECE regulation, or the upgraded requirements of Standard 202. The proposal to allow compliance with the ECE regulation during the interim responds to a petition for rulemaking by the American Automobile Manufacturers Association (AAMA) and the Association of International Automobile Manufacturers (AIAM) requesting that we consider the benefits of complying with the European regulation to be at least equivalent to those of complying with the existing requirements of Standard 202.

DATES: You should submit your comments early enough to ensure that Docket Management receives them not later than March 5, 2001.

ADDRESSES: You should mention the docket number of this document in your comments and submit your comments in writing to: Docket Management, Room PL–401, 400 Seventh Street, SW., Washington, DC, 20590. Comments may also be submitted to the docket electronically by logging onto the Dockets Management System website at *http://dms.dot.gov*. Click on ''Help & Information'' or ''Help/Info'' to obtain instructions for filing the document electronically.

You may call Docket Management at 202–366–9324. You may visit the Docket from 10 a.m. to 5 p.m., Monday through Friday.

FOR FURTHER INFORMATION CONTACT: For non-legal issues, you may contact Louis Molino of the Office of Safety Performance Standards, Vehicle Crashworthiness Standards, Light Duty Vehicle Division, NPS–11, (Phone: 202–366–2264; fax: 202–366–4329; E-mail: *lmolino@nhtsa.dot.gov*).

For legal issues, you may contact Otto Matheke of the Office of Chief Counsel, NCC–20, (Phone: 202–366–5263; Fax 202–366–3820).

You may send mail to both of these officials at the National Highway Traffic Safety Administration, 400 Seventh St., SW., Washington, DC, 20590.

SUPPLEMENTARY INFORMATION:

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I. The Safety Problem

Whiplash injuries, a set of common symptoms involving the soft tissues of the head, neck and spine, are believed to be associated with rapid motion of the head and neck relative to the torso in a crash. Symptoms of pain in the head, neck, shoulders, and arms may be present along with damage to muscles, ligaments and vertebrae, but in many cases lesions are not evident. The onset of symptoms may be delayed and may only last a few hours; however, in some cases, effects of the injury may last for years or be permanent. The relatively short-term symptoms are associated with muscle and ligament trauma, while the long-term ones are associated with nerve damage.[1]

Although whiplash injuries can occur in any kind of crash, they occur most often in rear-end collisions. When a vehicle is struck from behind, typically several things occur in quick succession to an occupant of that vehicle. First, from the occupant's frame of reference, the back of the seat moves forward into his or her torso, straightening the spine and forcing the head to rise vertically. Second, as the occupant's body is pushed forward by the seat, the unrestrained head tends to lag behind. This causes the neck to change shape, first taking on an S-shape and then bending backward. Third, the forces on the neck accelerate the head, which catches up with—and, depending on the seat back stiffness and if the occupant is using a shoulder belt, passes—the restrained torso. This motion of the head, which is like the lash of a whip, gives the resulting neck injuries their popular name. However, at what point in this motion the injury occurs is still a matter of debate.

We estimate from National Analysis Sampling System (NASS) data that between 1988 and 1996, 805,581 whiplash injuries (non-contact Abbreviated Injury Scale (AIS) 1 neck) occurred annually in all crashes in passenger cars (PCs), and in LTV's (light trucks, multipurpose passenger vehicles and vans). The average cost (excluding property damage) of such an injury is $6,485, resulting in a total annual cost of $5.2 billion.

[1] Summary of the highlights of Traffic Safety and Auto Engineering Stream, World Congress on Whiplash-Associated Disorders, February 1999, Vancouver, Canada *http://www.whiplash99.org/highlights/index.htm*.

The potential for whiplash injuries is influenced by the ability of several aspects of vehicle design, including vehicle structure, seats and head restraints, to absorb and control crash forces. In addition to integral and adjustable head restraints, which are designed to maintain their position relative to the seat back during a crash, several manufacturers have recently introduced new seat and head restraint designs that allow the head restraints to actively move closer to the occupant's head during a rear impact of the vehicle. Volvo has introduced a system it has labeled as WHIPS (Whiplash Head Impact Protection System) in which the seat back recliner is designed to give a controlled rearward motion of the seat back relative to the seat base in a rear impact—allowing the torso to move backward. In the first phase the seat back translates rearward for the purpose of reducing relative motion of the seat back—reducing relative motion of the head and torso and allowing the head to move closer to the head restraint. The second phase involves rearward folding of the seat back, with the center of motion in the recliner. This reduces acceleration of the occupant while absorbing energy. Saab has incorporated an active and adjustable head restraint into the front seat backs of its 9–3 and 9–5 models. Known as the Saab Active Head Restraint System, it moves the head restraint forward and upward as the seat occupant moves backward during and after a rear impact. Model year 2000 Infiniti I30s, Buick LeSabres and Pontiac Bonnevilles also have active front seat head restraints. The Insurance Institute for Highway Safety (IIHS) has attempted to determine the potential contributions of the advanced seats like the Volvo seat and of active head restraints through dynamic testing of those designs. More information on these tests is discussed in the Background section of this document. Two suppliers, TRW and Breed Siemens Restraint Systems, are each in the process of developing an inflatable head restraint that is activated in rear impacts.

This notice focuses on the potential for reducing whiplash through requiring improvements in head restraints. A historical examination of head restraint standards in this country indicates that the focus has been the prevention of neck hyperextension (the rearward movement of the head and neck over a large range of motion relative to the torso), as opposed to controlling lesser amounts of head and neck movement in a crash. The predecessor to Federal Motor Vehicle Safety Standard 202 (Standard 202) was General Services Administration (GSA) Standard 515/22, which applied to vehicles purchased by the U.S. Government and went into effect on October 1, 1967. GSA 515/22 required that the top of the head restraint achieve a height 700 mm (27.5 inches) above the H-point. The H-point is defined by a test machine placed in the vehicle seat (SAE J826, July 1995). From the side, the H-point represents the pivot point between the torso and upper leg portions of the test machine. It can be thought of, roughly, as the hip joint of a 50th percentile male occupant viewed laterally. Also in 1967, research using staged 48.3 kph (30 mph) crashes concluded that a head restraint 711 mm (28 inches) above the H-point was adequate to prevent neck hyperextension of a 95th percentile male.[2] Standard 202, which became effective on January 1, 1969, required that head restraints be at least 700 mm (27.5 inches) above the seating reference point or limit the relative angle between the head and the torso to 45 degrees or less during a dynamic test.

Current research indicates that whiplash may occur as a result of head and neck movements insufficient to cause hyperextension. Low speed staged impacts indicate that mild whiplash symptoms can occur without exceeding the normal range of motion.[3] Other research shows that 70.8 kph (44 mph) impacts can be sustained without injury if no relative motion occurs between the head and torso.[4] A Volvo study reported that, when vehicle occupants involved in rear crashes had their heads against the head restraint during impact, no injury occurred.[5] The same study related a rear impact simulation computer model to actual crash data and identified the rate of volume change in the cervical spinal canal as a possible predictor of whiplash injury. Other predictors identified were neck shear force, neck tensile force and head angular acceleration. A study of Volvo vehicles involved in rear impacts showed that a significant increase in injury duration occurred when the occupant's head was more than 100 mm (4 inches) away from the head restraint at the time of the rear impact.[6]

Although there seems to be no clear consensus in the biomechanics community about the mechanism for whiplash injuries, several hypotheses have been proposed based on investigations using animals, volunteers, and human surrogates. Animal research at Chalmers University suggests that rapid head/neck motion, within the normal range, can cause spinal canal pressures to damage nerve ganglia.[7] Other studies have attributed whiplash injuries to damage to the highly innervated cervical facet joints. Researchers at the Medical College of Wisconsin propose that local compression in the lower cervical spine and sliding along the facet joint may cause the excitation of local pain fibers, micro-damage to the cartilage plates and squeezing of the synovial space in the facet joints.[8] Similarly, a study performed in Japan using cineradiography (x-ray motion pictures) on human volunteers to study vertebral motion, hypothesized that the upward ramping of the torso due to the straightening of the natural spine lordotic curvature causes compression of the cervical spine and an unnatural S-shape of the cervical spine.[9] At the mid-portion of this unnatural S-shape, large rotations may occur which stretch the ligaments or damage the facet joint.

In 1995, the National Highway Traffic Safety Administration (NHTSA) performed a survey of the relative position of occupants' heads and head restraints on 282 vehicles. The survey examined relative position of the head to the restraint, how the head restraint was adjusted and if the head restraint could potentially have been adjusted higher. The tops of 59 percent of adjustable and 77 percent of integral head restraints were at or above the occupant's ear—a point equivalent to the head center of gravity. NHTSA also estimated the backset of these head restraints—the horizontal distance from the back of the occupant's head to the head restraint. Sixty-nine percent of adjustable head restraints and 77

[2] Severy *et al.* (1968) Backrest and Head Restraint Design for Rear-End Collision Protection. SAE 680029.

[3] McConnell *et al.* (1995) Human Head and Neck Kinematics After Low Velocity Rear-End Impacts—Understanding "Whiplash." SAE 952724.

[4] Mertz and Patrick (1967) Investigation of the Kinematics and Kinetics of Whiplash. Proceedings of the 11th STAPP Car Crash Conference, pp. 267–317.

[5] Jacobsson *et al.* (1994) Analysis of Head and Neck Responses in Rear End Impacts—A New Human-Like Model. Volvo Car Corporation Safety Report.

[6] Olsson *et al.* (1990) An In-depth Study of Neck Injuries in Rear-end Collisions. IRCOBI, pp. 269–280.

[7] Svensson *et al.* (1993) Pressure Effects in the Spinal Canal During Whiplash Extension Motion: A Possible Cause of Injury to the Cervical Spinal Ganglia. IRCOBI, pp. 189–200.

[8] Yoganandan *et al.* (1998) Biomechanical Assessment of Whiplash. In: Frontiers in Head and Neck Trauma: Clinical and Biomechanical, pp. 344–373.

[9] Kaneoka and Ono (1998) Human Volunteer Studies on Whiplash Injury Mechanisms. In: Frontiers in Head and Neck Trauma: Clinical and Biomechanical, pp. 313–325.

percent of integral head restraints had a backset of less than 100 mm (4 inches). When combined height and backset position was assessed, 53 percent of adjustable and 70 percent of integral head restraints were both above the ear and less than 100 mm (4 inches) from the head. Half of adjustable head restraints were left in the lowest adjustable position and three quarters of these could have been raised to decrease whiplash potential by bringing the head restraint higher in relation to the occupant's head height.

The continued persistence of whiplash injuries indicates that Standard 202 should be revised. The current state of knowledge indicates that limiting hyperextension of the neck does not prevent the occurrence of whiplash and that controlling even smaller amounts of rapid head and neck movement relative to the torso would be more effective. The current regulation requires a head restraint height of 700 mm (27.5 inches) to prevent hyperextension and has been shown to accomplish this for occupants as large as 95th percentile males. However, the current regulation has no lower limit on head restraint position. Therefore, if an adjustable head restraint is not raised to the 700 mm (27.5 inch) level, hyperextension may be more likely for some occupants. Additionally, if an existing head restraint is not designed to exceed the current height requirement and to also limit backset distance, it will not be capable of controlling small amounts of head and neck movement relative to the torso for many occupants. These factors may be playing a large role in the persistence of whiplash. NHTSA has tentatively concluded that an upgrade to Standard 202 is required to foster further gains in neck injury protection in rear impacts.

II. Background

A. Studies of Head Restraint Effectiveness

Since January 1, 1969, passenger cars have been required by Standard 202 to have head restraints in the front outboard seating positions. Head restraints must either (a) be at least 700 mm (27.5 inches) above the seating reference point in their highest position and not deflect more than 100 mm (4 inches) under a 373 Nm (3,300 inch-pounds) moment, or (b) limit the relative angle of the head and torso of a 95th percentile dummy to not exceed 45 degrees when exposed to an 8 g acceleration. Standard 202 was extended to light trucks and vans under 10,000 pounds, effective September 1, 1991.

In 1982, NHTSA assessed the performance of head restraints installed pursuant to Standard 202 and reported that integral head restraints are 17 percent effective at reducing neck injuries in rear impacts and adjustable head restraints are 10 percent effective at doing so. The difference was due to integral head restraints being higher with respect to the occupant's head than adjustable head restraints, which were normally left down.

IIHS evaluated and rated head restraints in 1995, 1997 and 1999. In 1998, in conjunction with the State Farm Insurance Company (State Farm), IIHS compared the conclusions from the 1995 and 1997 evaluations to crash data.[10] In the 1997 evaluation, the head restraints of 214 1997 model year (MY) vehicles were rated based on their position relative to the 50th percentile male head. The restraints were ranked according to the prevailing view of the biomechanics community that head restraints that are in close proximity, both horizontally and vertically, to the center of gravity of the head are more effective. The vertical reference value used in the evaluation of each head restraint was the distance from the top of the head to the head's center of gravity. The vertical reference measurement of 90 mm (3.5 inches) was taken from the 50th percentile adult male dummy drawing produced by the University of Michigan. The height of a head restraint was rated as ''marginal'' if the restraint's top was 90 ± 10 mm (3.5 ± 0.4 inches) below the top of the head form. The vertical rating was ''good'' if the distance from the top of the head form to the top of the restraint was less than 60 mm (2.36 inches) (*i.e.,* the top of the head restraint was at least 30 mm (1.2 inches) above the head's center of gravity).

The reference value used to evaluate backset, 100 mm (4 inches), was based on a 1990 study showing a statistical relationship between the backset larger than 100 mm (4 inches) and the duration of neck symptoms. The backset of a restraint was rated as ''marginal'' if the horizontal distance between the head form and restraint was 100 ± 10 mm (4 ± 0.4 inches). The backset was rating as ''good'' if the distance was less than 70 mm (2.8 inches). A restraint's overall rating was the lower of the height and backset scores. The results of the IIHS study and the rating criteria are presented in Table 1.

TABLE 1.—1999 IIHS HEAD RESTRAINT STUDY

IIHS rating	Number of vehicles	Percent	Distance down from top of head	Backset
Good	10	5.4	60 mm (2.36 in.) or less	70 mm (2.76 in.) or less.
Acceptable	50	26.9	60–80 mm (2.36–3.15 in.)	70–90 mm (2.76–3.54 in.).
Marginal	60	32.3	80–100 mm (3.15–3.94 in.)	90–110 mm (3.54–4.33 in.)
Poor	66	35.5	100 mm (3.94 in.) or greater	110 mm (4.33 in.) or greater.
Total	186	100		

Scores were reduced for adjustable head restraints since IIHS contends that field observations have shown that they typically are not adjusted properly. Adjustable head restraints without locks were evaluated based on their lowest and most rearward position of adjustment. For adjustable head restraints with locks, IIHS rated the restraint according to its locked position, but downgraded the rating by one category based on data establishing that few users properly adjust head restraints.

Because of variations in the shapes of head restraints, it is not possible to accurately correlate head restraint height as measured by IIHS and the height as measured by the method in Standard 202. The IIHS method evaluates head restraint height by

[10] This study is summarized in the May 22, 1999 edition of IIHS' Status Reports (*http://www.hwysafety.org*).

measuring the difference in vertical height between the top of a special (50th percentile male) head form mounted on a standard H-point machine and the top of the head restraint. The Standard 202 method measures along the torso line (which has an angle θ with respect to the vertical—see Figure A) from the H-point on the vehicle seat to the point at which the torso line intersects with the upper surface of the head restraint.

Assuming an idealized head restraint shape, a simple relationship between the two measurement methods can be developed as shown in Figure A. The dimension of this figure assume a torso angle (θ) of 25 degrees from the vertical and a distance from the H-point to the top of the head of 755 mm (29.7 inches). Figure B is a graphical depiction of how head restraints of 700 mm (27.5 inches), 750 mm (29.5 inches) and 800 mm (31.5 inches) fare with respect to the IIHS dimensional rating technique. For any backset up to 70 mm (2.8 inches), the 800 mm (31.5 inches) high head restraint is always rated ''good.'' A 700 mm (27.5 inches) high head restraint can never be rated better than ''poor'' for any backset. A 750 mm (29.5 inch) high head restraint is ''good'' for backsets up to 30 mm (1.2 inches) and ''acceptable'' for backsets up to 73 mm (2.9 inches).

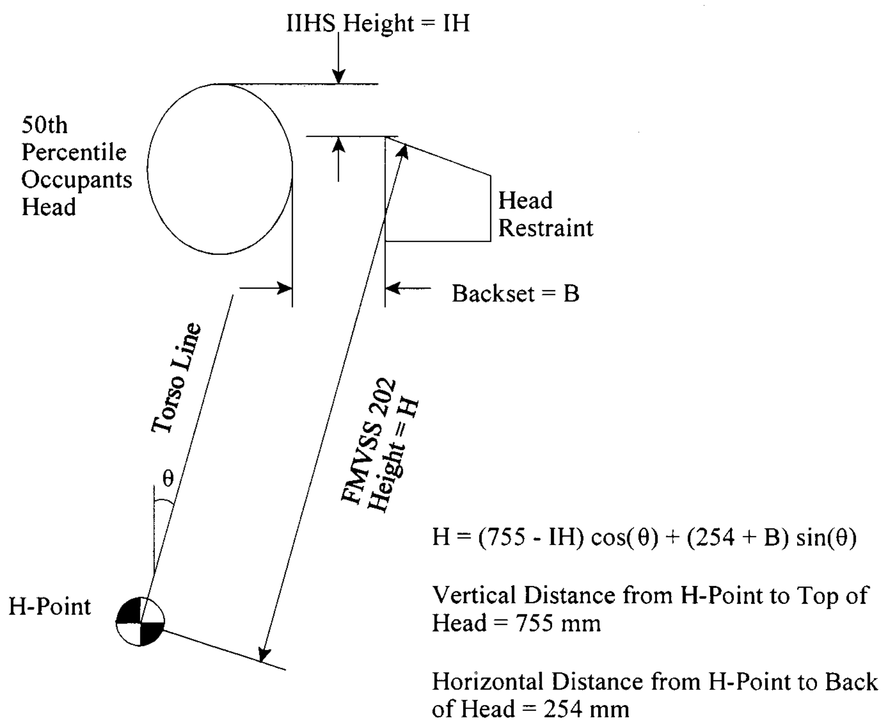

Figure A - Geometric Basis of IIHS and Standard No. 202 methods of determining head restraint height.

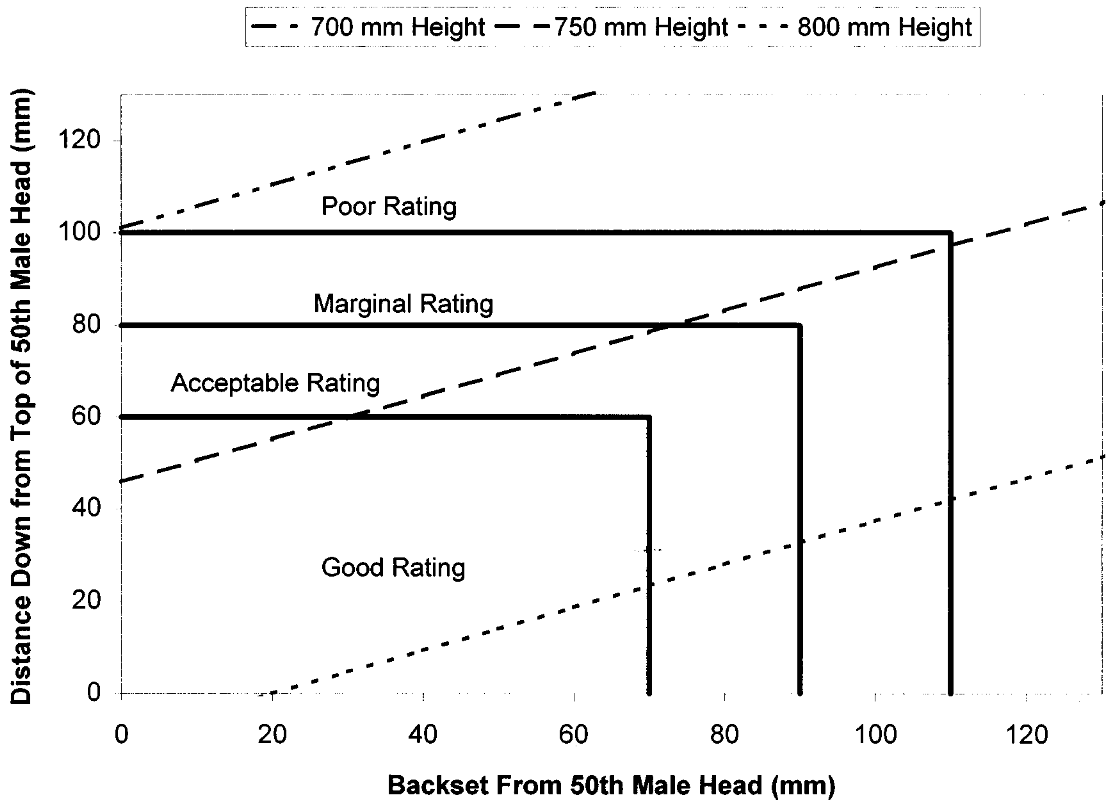

Figure B - Relationship between Standard No. 202 Measured Heights and IIHS Dimensional Ratings.

The 1998 joint State Farm-IIHS study compared the ratings applied in the 1995 and 1997 IIHS evaluations to actual whiplash claims. The new study, based on detailed analyses of more than 5,000 State Farm claims involving midsize cars struck in the rear by other vehicles, indicates that head restraints rated ''good'' in the 1995 and 1997 IIHS evaluations offered better protection in real-world crashes than those rated ''poor.'' According to the State Farm-IIHS study, drivers in cars with head restraints rated ''good'' by IIHS are 24 percent less likely to suffer neck injuries in rear-end crashes than drivers with head restraints rated ''poor.'' Percentages of drivers with neck injuries ranged from 22 percent of those with ''good'' head restraints to 27 percent of those with ''poor'' head restraints. The State Farm-IIHS study also found that female drivers have higher neck injury rates overall than male drivers—30 percent versus 23 percent, but that the likelihood of neck injury was 36 percent lower among female drivers with ''good'' head restraints than among females with ''poor'' restraints. Among male drivers, the State Farm-IIHS study found that the risk reduction was 10 percent with ''good'' head restraints. However, it should be noted that there were a limited number of ''good'' head restraints in the study (3 vehicles, all Volvos). Thus, the results are not conclusive.

The State Farm-IIHS study appears to verify that higher head restraints that are also closer to the back of an occupant's head (*i.e.,* have less backset) reduce the risk of whiplash. The study also found measurable improvement as the ratings increased between head restraints in the four categories established by IIHS—poor, marginal, acceptable and good. The State Farm-IIHS study does not, however, allow for analysis of the virtues of increases in height with no change in backset or reductions in backset independent of changes in height. Further, the IIHS methodology accounted for the fact that adjustable restraints are often not placed in their highest and closest position, resulting in only integral restraints being rated as ''good.''

IIHS reported in its 1999 head restraint evaluation that it dynamically tested two advanced head restraint designs and applied the Chalmers University NIC criterion to the results. These were moving rigid barrier to full vehicle impacts at barrier speed of 24 kph (15 mph). IIHS tested the Saab Active Head Restraint System and the Volvo WHIPS seat. The two designs had significantly lower NIC values than even ''good'' non-deploying designs.

B. December 1996 Request for Comments

In 1996, NHTSA issued a Technical Report entitled, ''Head Restraints—Identification of Issues Relevant to Regulation, Design and Effectiveness.'' This report identified and examined issues related to the biomechanics of neck injury, whiplash rates, occupant and head restraint positioning and the state of contemporary and future head restraint designs. On December 19, 1996, NHTSA published a document in the **Federal Register** (61 FR 66992) alerting the public to the existence of the report and that the agency was interested in obtaining information and comments about the performance of head restraints and potential modifications to Standard 202. The December 1996 document contained questions regarding:

(1) The effectiveness of current designs and the potential for improvements to reduce injury;

(2) The adequacy of Standard 202's height requirements and the efficacy of new requirements such as backset and adjustable head restraint locks;

(3) The continued need for and possible changes to the existing dynamic test procedure;

(4) Potential conflicts between visibility and revised head restraint requirements;

(5) Whether NHTSA should harmonize its regulations with ECE requirements;

(6) Whether changes to Standard 202 should be synchronized with changes to Standard 207, Seating Systems; and

(7) The costs of whiplash injury in the United States and the costs and benefits of modifying Standard 202.

The agency received comments from four manufacturers (Volkswagen, Toyota, Volvo, and Ford), three safety advocacy organizations (Consumers Union (CU), Advocates for Highway Safety (Advocates) and IIHS), one equipment manufacturer, Cerviguard, one insurance company, Insurance Corporation of British Columbia (ICBC), and the Chalmers University of Technology (Chalmers).

None of the respondents submitting comments stated that current head restraint designs were sufficiently effective at preventing neck injuries. While Ford indicated that current ''designs have been shown to be effective at reducing the risk of neck injuries in vehicle crashes,'' it also stated that improved designs will require additional research and testing. Chalmers, ICBC, CU and Advocates stated that they believed current head restraint designs were not sufficiently protective against neck injuries. None of the commenters stated that the current required height for head restraints of 700 mm (27.5 inches) is sufficient. IIHS, whose comments were submitted prior to the completion of the 1998 State Farm-IIHS report, referred to its 1995 and 1997 studies of head restraints. These studies, based on an examination of the head restraint positions relative to the head, concluded that the majority of head restraints were inadequate. According to IIHS, only 2.3 percent of 1997 vehicles evaluated had ''good'' head restraints, thus indicating that the current dimensional requirements are not sufficient.

Advocates indicated that most head restraint designs allow too much backset and that this should be limited to ''considerably'' less than four inches. CU stated that head restraints should have a minimum height of 737 mm (29 inches) to 762 mm (30 inches), but should be able to adjust even higher. Advocates urged the agency to require adjustable head restraints to lock in position, considering this ''a crucial aspect of restraint design and performance.'' It stated that it believes many of the current designs allow vertical collapse of the head restraints in rear crashes especially when the top of the head restraint is below the head's C.G. Chalmers and CU also endorsed adjustable head restraints having locks. Toyota said it believes that, at a minimum, the vertical adjustment should lock.

In reference to changes to test procedures, Chalmers stated that a dynamic test procedure is a necessity for new designs known as ''active'' head restraints. These head restraints move forward and/or higher in a crash. Chalmers also stated that this test should use a Rear Impact Dummy (RID) neck (developed by Chalmers) mounted on a Hybrid III dummy. The RID neck was developed at Chalmers because they thought the Hybrid III neck was too stiff in the midsagittal plane. Advocates, Toyota and Cervigard also expressed concern about the biofidelity of the Hybrid III neck. Volvo advised ''that the present 8g alternate standard in Standard 202 should be deleted and no new dynamic performance standard should be adopted until more knowledgeable injury mechanisms have been acquired and until relevant test procedures and improved test dummies have been developed.'' This would include a change to the dummy spine as well as the neck.

Comments on the impact of potential changes to head restraint requirements included concerns about effectiveness and degradation in visibility. Volvo stated that head restraint designs may not be optimal for occupant protection because manufacturers must also consider occupant comfort and visibility through the vehicle from the rear. Advocates noted that increasing the protective value of head restraints will be affected by comfort considerations as well as lateral and rear visibility issues. Chalmers said it believes that head restraints which are ''actively positioned during impact, would solve both the problems of visibility and injury prevention.''

The comments also indicated support for harmonizing Standard 202 with Economic Commission for Europe (ECE) Regulation 25.[11] Advocates favored harmonization, but said that the modified Standard 202 must go further. The organization said it believes the agency should investigate the merits of requiring head restraints in rear seats, as is required by ECE 25. However, it also mentions that this might conflict with tethered child safety seats and rear window visibility. CU recommended harmonization with ECE 25 as a move towards the goal of improving head restraints. This includes the provision for head restraints in the rear seats. However, it also endorsed other changes to the standard. Volkswagen endorsed harmonization with ECE Commission Directive 96/37/EC which combines ECE 25 (Head Restraints) and ECE 17 (Seats). Toyota stated that if the agency raises the required height for head restraints, it should match ECE 25. Volvo asked that NHTSA simply ''monitor'' the European standard. Ford stated that it ''strongly supports harmonization with other world regulations to promote world trade, providing it does not compromise safety or the integrity of the vehicle.'' It supported modification of Standard 202 on this basis.

Most of the commenters also favored coordinating changes to Standard 202 with changes to Standard 207 on the basis that seat and head restraint performance are closely linked because the longitudinal stiffness of a seat back will have an impact on the relative movement of the head and torso in the event of a crash. Chalmers indicated that their dynamic test proposal inherently coordinates changes to Standards 202 and 207. Advocates said that it believes coordinating the head restraint standard with any seat back standard is worthy of exploration and urged NHTSA to give explicit attention to the relationship between head restraints and integrated seat/head restraint systems. Volvo stated that in the short term no change should be made to either Standard 202 or 207 until more research has been done. At the same time, it provided information on its Whiplash Protection Study (WHIPS) in which Volvo modified its standard seat to optimize it for whiplash protection.

Only one commenter, ICBC, submitted data on the costs of whiplash and the benefits of reducing whiplash

[11] Economic Commission for Europe (ECE) Regulation 25—*Uniform Provisions Concerning the Approval of Head Restraints (HeadRests), Whether or Not Incorporated in Vehicle Seats* is similar to Standard 202 in that the same strength/displacement test procedure and performance values are required. The head restraint height is measured in the same way by both regulations, but the required heights differ. ECE 25 specifies that head restraints he higher than the current version of Standard 202. In addition, the current ECE 25 requires all forward facing outboard seats to have head restraints.

injuries. ICBC stated that 45,437 British Columbians suffered whiplash in 1996. Since the population of British Columbia is about 1 percent of the U.S. population, extrapolating this figure to the U.S. would imply that there were 4,543,700 whiplash injuries in the U.S. during 1996. This figure is more than five times NHTSA's estimate of the number of whiplash injuries in the U.S. ICBC estimates that each whiplash costs $8,199 U.S. If this figure were multiplied by the number of extrapolated injuries, this would suggest a total cost of $37 billion U.S. That is more than seven times greater than NHTSA's estimate. NHTSA does not know why the number of whiplashes estimated from the ICBC figures are so much higher than the NHTSA estimate. While the agency has not examined the methodology used by ICBC to calculate its estimate, it is possible that the number of insurance reported whiplashes may overstate the actual incidence of injury.[12] The agency's whiplash estimate is based on crash data generated by police reported crashes where one or all of the vehicles involved are towed away from the scene. Since many whiplashes occur in crashes where no vehicle is towed and no police report is made, a correction factor was used to adjust the estimate for these non-towed crashes.

C. AIAM/AAMA Petition

On August 13, 1997, the American Automobile Manufacturers Association (AAMA) and the Association of International Automobile Manufacturers (AIAM) submitted a joint petition for rulemaking requesting that NHTSA consider the possibility of amending five safety standards so that these standards would be ''functionally equivalent'' to corresponding ECE standards. The petition defined ''functional equivalence'' through comparison with harmonization:

A harmonized regulation would contain and define either (1) a single set of performance requirements that a vehicle could be ''certified'' to and sold anywhere in the world or (2) common test conditions and procedures, common test devices and measurement techniques, and common test criteria limits. A functionally equivalent regulation may have any number of ''technical'' differences but would provide an equivalent level of real world performance despite these differences.

The petition did not offer any further illumination of what ''technical'' differences may exist between two regulatory schemes that are ''functionally equivalent.'' The AAMA/AIAM petition implies that two standards should be considered as functionally equivalent if they are similar and offer equivalent levels of performance.

AAMA/AIAM indicated that the European standards, ECE 17 and ECE 17.04,[13] differ from Standard 202 in the requirements for the height and width of head restraints, the energy absorption characteristics of the front surface of restraints and in the requirement for rear head restraints. The petition requested that NHTSA amend S4.3 of its standard to require that the top of a fully extended head restraint be not less than 800 mm above the seating reference point and that the top of a head restraint, when adjusted to its lowest adjustment position, be not less than 750 mm above the seating reference point. The addition of these proposed amendments, in AAMA/AIAM's view, would make Standard 202 functionally equivalent to the European regulations. Further, AAMA/AIAM requested that a new provision be added to Standard 202 indicating that head restraints meeting the requirements of ECE 17.05 or ECE 25.04 or EEC 74/408 be deemed to have met the requirements of Standard 202. In order to accommodate the product cycles of their members, AAMA/AIAM suggested that the upgraded Standard 202 have an effective date of September 1, 2004.

III. Overview of Proposal

NHTSA is proposing a series of amendments to upgrade Standard 202 to improve the protection provided to occupants. The agency anticipates that these amendments will provide safety benefits in all crashes. However, we are limiting our benefits analysis to rear end collisions only. These new requirements would require that head restraints, when adjusted to their lowest possible adjustment position, be at least 50 mm (2 inches) higher than they are currently required to be. (Note: This proposal is presented in the International System of Units (SI) with the English Units conversion provided in parenthesis for convenience. A final rule will be presented in only SI units.) It would also require front seat head restraints to be able to achieve a height 100 mm (4 inches) higher than currently required, and lock in this adjustment position as well as lock at the highest adjustment position. Rear seat head restraints would also be required to lock in the highest adjustment position. Head restraints would also be subject to a new requirement limiting the amount of backset, *i.e.,* distance between the back of an occupant's head and the front of the head restraint, to 50 mm (2 inches). NHTSA is also proposing that head restraints be required in the rear outboard seating positions. These upgraded requirements appear in the portion of the regulatory text which would apply to vehicles manufactured after the first occurrence of September 1, three years after publication of the final rule.

The agency proposal for upgrading Standard 202 would harmonize Standard 202 with the requirements for head restraints in ECE Regulation 25 in some respects. The proposed height requirements are identical to those in ECE 25. The agency proposal also contains provisions establishing performance criteria for energy absorption by the front surface of head restraints. Finally, as amended, Standard 202 would require rear seat head restraints.

However, the proposal would set different requirements for head restraint width and gap measurement for adjustable restraints than those found in ECE 25. Further, it would add requirements for backset and adjustment retention locks. It would also include a dynamic compliance option not found in ECE 25. In the current and proposed Standard 202, compliance may be measured in one of two ways. The first way is to meet all static dimension and strength requirements, while the second way is to meet a dynamic test. The proposal would modify the required level of performance in the dynamic compliance option to reflect the proposed height and backset requirements.

Prior to the first occurrence of September 1, three years after publication of the final rule on which compliance with the upgraded requirements becomes mandatory, the manufacturers would be given the option of complying with any of three different sets of requirements: the existing requirements of Standard 202, the existing requirements of ECE 25, or the upgraded requirements of Standard 202. Consistent with other recent

[12] NHTSA observes that the 1998 State Farm-IIHS study revealed that the overall neck injury rate in Michigan, the study's only no-fault state, was 13 percent compared with 26 percent in other states, without no-fault liability systems. This suggest that the availability of fault-based compensation systems may lead to higher reported rates of whiplash.

[13] The European regulations, EEC 74/408, as amended by Directive 96/37/EC, promulgated by the European Union, and ECE 17.04, established by the UN Economic Commission for Europe (ECE), apply to vehicles with a seating capacity of nine passengers or less. These regulations, which principally govern seats and seating systems, are identical to each other. ECE 25, which applies to head restraints, is incorporated into ECE 17.04. Therefore, for the purposes of head restraints, ECE 17.04 and ECE 25 may be considered to be one and the same.

amendments to our Safety Standards, the compliance option would have to be selected prior to certification of the vehicle, and the selection could not be changed thereafter.

IV. Proposed Upgraded Requirements

A. Height Requirements

Standard 202 currently requires that all head restraints be capable of achieving a height where the top of the head restraint must be at least 700 mm (27.5 inches) above the seating reference point measured parallel to the torso reference line. For vehicles produced on or after the first occurrence of September 1, three years after publication of the final rule, NHTSA proposes to change this requirement to 800 mm (31.5 inches) above the H-point for front seat head restraints. The proposal adds a lower limit on all required head restraints including those in the rear outboard seats, requiring that head restraints may not be less than 750 mm (29.5 inches) above the H-point. Therefore, under the proposal, front integral head restraints must have a minimum height of 800 mm (31.5 inches) and front adjustable head restraints must be capable of achieving a height of at least 800 mm (31.5 inches) and cannot be adjusted below 750 mm (29.5 inches). Rear integral restraints must have a minimum height of 750 mm (29.5 inches) and rear adjustable head restraints must not be adjustable to a height below 750 mm (29.5 inches). Research indicates that, for many occupants, in order to prevent hyperextension or lesser movements of the head and neck in relation to the torso that result in injury, head restraints must be higher than currently required by Standard 202 and close to the rear of the head.

The proposed alterations in the height requirements are intended to prevent whiplash injuries by requiring that head restraints be high enough to limit the movement of the head and neck, even if such movements do not result in hyperextension of the neck. The persistence of whiplash injuries in current vehicles indicates that current designs are not preventing whiplash injuries from occurring. Research has led to the conclusion that prevention of hyperextension alone does not stop whiplash from occurring. Since a 700 mm (27.5 inch) high head restraint is capable of preventing hyperextension in many occupants, it seems likely that the persistence of whiplash may be the result of the inability of current head restraints to be positioned to sufficiently limit relative head and neck motion in the normal range of motion. Research conducted since the implementation of the current height requirement has shown that head restraints should be at least as high as the center of gravity (C.G.) of the occupant's head to adequately control motion of the head and neck relative to the torso. This does not mean that there would be no additional benefits for a head restraint with a height greater than the height of the head C.G. However, this is likely to be controlled by other factors such as backset, head restraint shape and the underlying structure of the head restraint under the upholstery. Therefore, the head restraint height relative to the head C.G. height will be used here as an indication of the adequacy of the proposed height dimension.

A 750 mm (29.5 inch) high head restraint would have a height above the C.G. of a 50th percentile male if the backset were 125 mm (5 inches) or less, and assuming a head C.G. 105 mm from the top of the head (See Figure B). The difference in erect seating height between a 50th and 95th percentile male is 58 mm (2.3 inches). The size of most adult heads is essentially the same. The difference between the base of the neck and the top of the head of a 50th and 95th percentile male is only 6 mm (0.2 inches). Therefore it is reasonable to assume that the vertical dimensions from the top of the head to the C.G. is nearly the same at 105 mm (4.1 inches). A 95th percentile male with a torso angle of 25 degrees will have the top and C.G. of the head 53 mm (2.1 inches) higher than a 50th percentile male.

It is also reasonable to assume that the back of the 95th and 50th percentile male heads are essentially aligned vertically with each other. Therefore, they would have the same distance from a head restraint with a flat vertical face. This is because the longer torso of the 95th male would tend to place it closer to the head restraint and the larger lower back and buttocks would push the H-point away from the back of the seat, resulting in no net change in backset (see Figure C). These assumptions about backset are consistent with the agency's laboratory observations and a 1998 Experimental Safety of Vehicles (ESV) Conference paper by Toyota.

Based on these assumptions, a 750 mm (29.5 inch) high head restraint would be as high as the 95th percentile male head C.G. if the backset were 13 mm (0.5 inches) or less (see Figure D). It would be 17 mm (0.7 inches) below the 95th percentile male head C.G. at 50 mm of backset. A 800 mm (31.5 inch) high head restraint would be as high as the 95th percentile male C.G. if the backset were 133 mm (5.3 inches) or less. It would be 38 mm (1.5 inches) above the 95th percentile male head C.G. at 50 mm of backset.

The proposal for the front seat of requiring head restraints to be capable of achieving an 800 mm height and have a backset no greater than 50 mm should assure that the top of the head restraint is above the head C.G. of virtually all front seat occupants. The proposal for front and rear seats requiring a minimum height of 750 mm and backset no greater than 50 mm will provide head restraints higher than the head C.G. of about 86 percent of the adult males (assuming a normal distribution of height). The C.G. height of a 99th percentile female reclined at 25 degrees is about 19 mm below a 750 mm (29.5 inches) high head restraint at a 50 mm (2 inch) backset. Therefore, this will provide head restraints higher than the head C.G. of nearly all adult females and 93 percent of all adults. In term of the rear seat target population, this proposal will cover an even higher percentage of rear seat occupants than it would of the entire population of occupants. This is because more children occupy the rear seats and larger occupants rarely sit in the rear where there is generally less room.

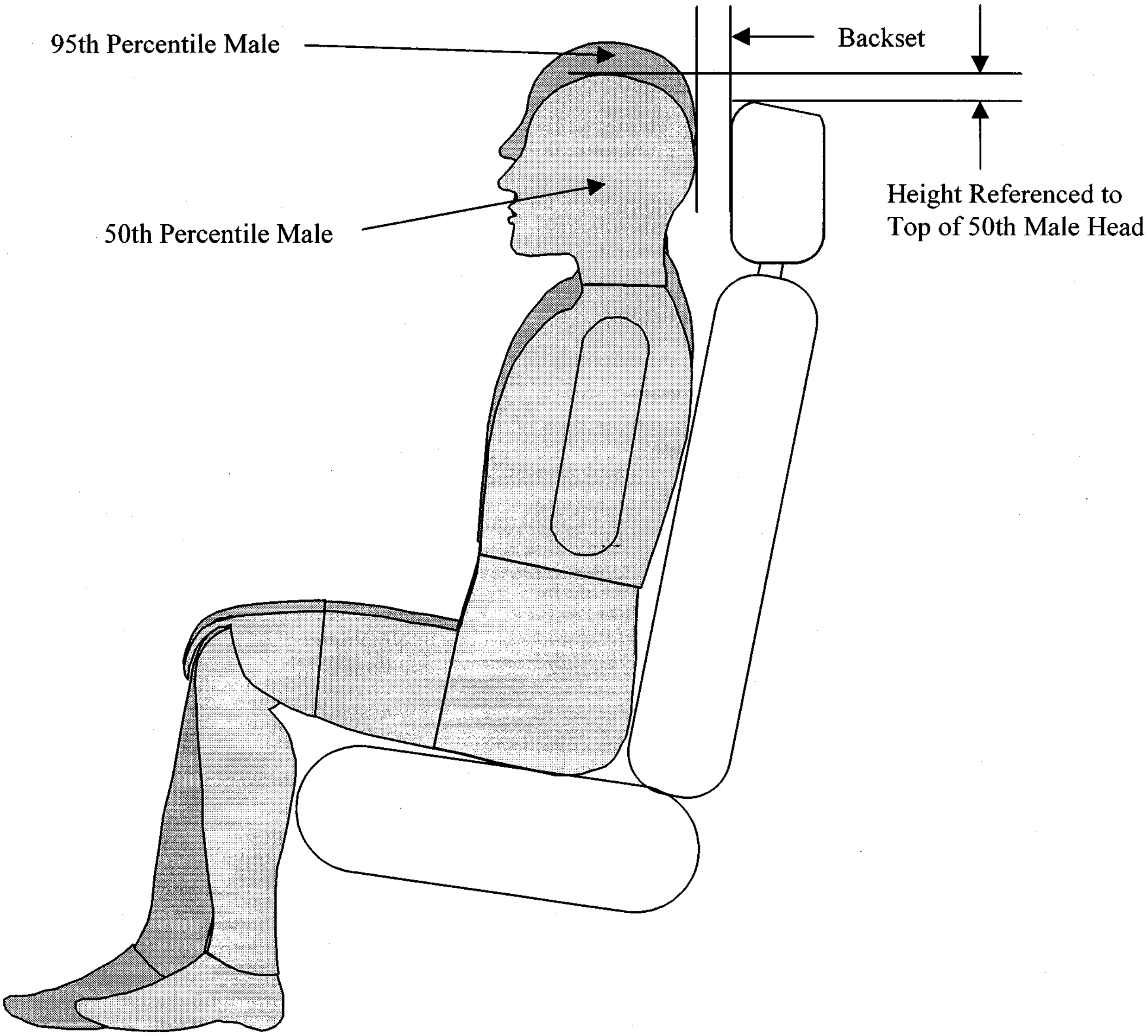

Figure C - Seated 50th and 95th percentile males. Backset dimension assumed to be the same for both occupants.

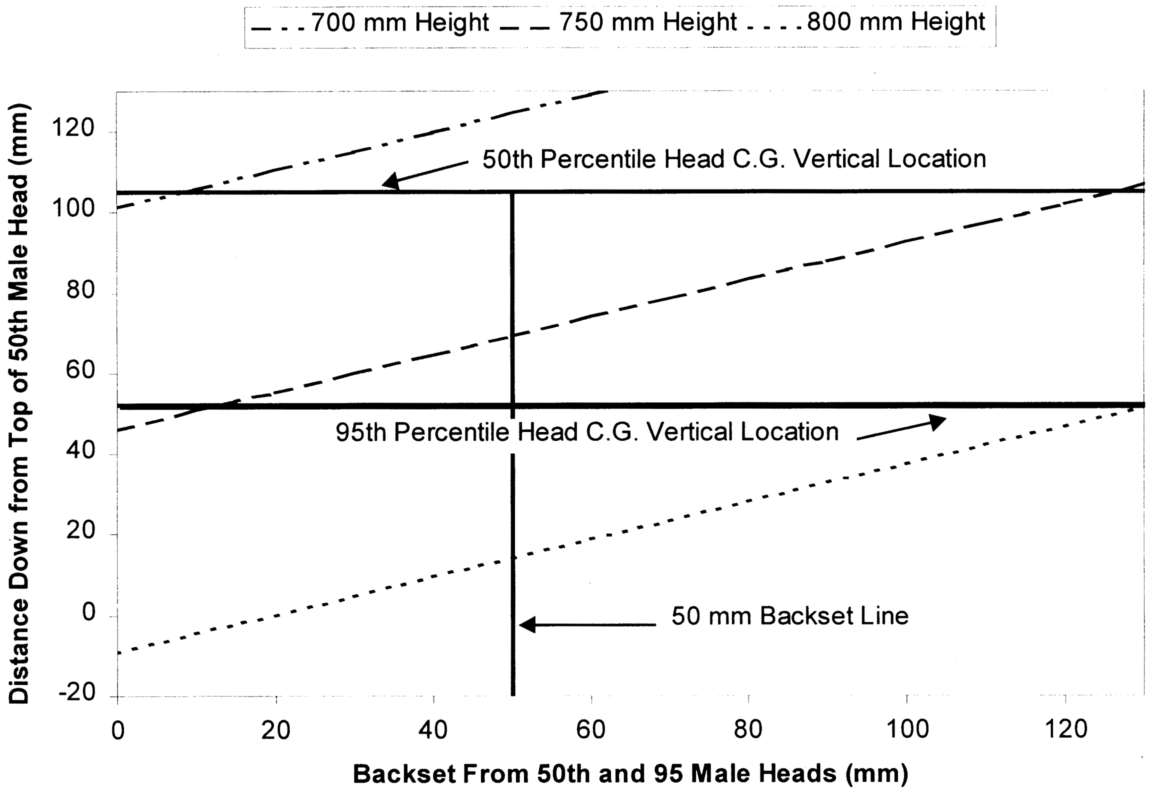

Figure D - Relative location of 50th and 95th percentile male head C.G. relative to head restraint height and backset.

The recent State Farm-IIHS study also suggests that head restraints that are higher in relation to the head center of gravity and closer to the back of the head provide greater protection against whiplash. The agency notes that head restraints rated "good" by IIHS—integral restraints with a height less than 60 mm (2.36 inches) below the top to the head and within 70 mm of the rear of the head—reduced the likelihood of whiplash by 36 percent in females and 10 percent in males. Figure B shows that an 800 mm (31.5 inches) high head restraint is likely to be high enough to be rated as "good" at all backsets within the "good" range. NHTSA believes that the proposed requirement for backset, in conjunction with the proposed height requirements, would lead to a significant improvement in safety.

Although the agency tentatively concludes that its proposed 800 mm (31.5 inches) height requirement would offer significant benefits for people taller than 50th percentile males, the agency wishes to know if additional safety benefits could be realized by requiring head restraints to be capable of achieving a somewhat greater height. Therefore, NHTSA requests comments on:

1. The marginal benefits and costs of requiring head restraints to be capable of achieving a height greater than the one proposed in this notice.

2. Other issues that may be raised by a height requirement greater than the proposed one, including those associated with the potential effects on visibility, seat adjustability and compliance with other safety standards, e.g., Standard 201, "Head Protection in Interior Impact."

B. Backset Requirement

NHTSA is also proposing to add, for vehicles produced on or after the first occurrence of September 1, three years after publication of the final rule, a backset requirement of no more than 50 mm (2 inches) for front and rear head restraints. The consensus of the biomechanics community is that the backset dimension has an important influence on the forces felt by the neck and the length of time a person is disabled by injury. This judgment is based on testing, computer modeling and real world crash data. As far back as 1967, Mertz and Patrick showed that loading on the head during a rear impact is minimized by reducing the initial separation between the head restraint and head. With the head initially against the head restraint, a volunteer test subject endured a 71 kph (44 mph) rear impact without discomfort. Research presented at the 1990 International Research Council on the Biomechanics of Impact (IRCOBI) examined 25 rear impacts involving 33 occupants of Volvo cars. The study results showed a statistically significant increase in neck injury duration when there was more than 100 mm (4 inches) of backset. A 1994 study conducted by Volvo found additional potential injury reduction as the backset approaches zero, allowing no relative motion between the head and torso upon rear impact. IIHS, in its studies of head restraints, considered a backset of 70 mm (2.8 inches) or less to be "good."

NHTSA has tentatively concluded that adding a requirement specifying a limit on backset would result in reduced angular displacement between the head and torso in a crash. One method the agency used to assess the potential benefits of a backset limit was through a computer modeling study in which the backset dimension was defined as the distance between two vertical lateral planes; one plane passing through the rearmost point on the headform and the other passing through the forwardmost part of the head restraint at its centerline. A seat model intended to represent a 1986–1994 Pontiac Grand Am was used with the head restraint positioned in 21 different configurations with varying heights and backsets. The vehicle seat, as modeled, was relatively stiff in the longitudinal direction in comparison to those currently on the market. Another set of data was generated with the hinge joint kept completely rigid. This was intended to simulate a rear seat that has its seat back structure rigidly attached to the vehicle body, such as is the case for many passenger cars. A model of a Hybrid III 50th percentile male was the seat occupant.

For both seat stiffnesses, no head-to-torso angular rotation was greater than 2 degrees for head restraints above 750 mm (29.5 inches) and backsets 50 mm (2 inches) and closer. At backsets up to 100 mm (4 inches), all head-to-torso angular rotations were less than 21 degrees for head restraints above 750 mm (29.5 inches). At a backset of 150 mm (6 inches), head rotations of 27 and 44 degrees occurred at head restraint heights of 750 mm (29.5) and 800 mm (31.5 inches), respectively.

The computer modeling indicates that the lowest head-to-torso rotation value was seen when the backset was approximately 50 mm (2 inches). NHTSA tentatively concludes that this amount of backset is appropriate for all outboard seating positions.

The agency understands that there are differences in the way occupants adjust and sit in seats and that the backset measurement device being used may not capture this variety completely since it attempts to represent the head position of a 50th percentile male in a seat with a 25 degree inclination from the vertical. A steeper seat back inclination will further reduce the backset.

The agency also believes that physical differences in seat design may contribute to seat performance. In fact, National Automotive Sampling Systems (NASS) crash data indicate that the whiplash rate for rear seat occupants is significantly lower than that of front seat occupants. One explanation may be that many rear seats are often configured differently than front seats and frequently do not have adjustable backs. Adjustable seat backs allow wide variations in location of the head restraint relative to the user as the seatback angle changes through the range of adjustment.

In making the backset proposal, the agency has attempted to balance the need for both occupant safety and comfort while considering potential misadjustment. The agency believes the backset requirement is practicable—the majority of occupants should comfortably fit in seats with a 50 mm (2 inch) backset and it is well within the capability of manufacturers to produce seats with this backset.

The agency measured 14 MY 1999 vehicles and found that the front seats of the Toyota Camry, Chevy C1500, Chevy S10, Saab 9–5, and Chevy Malibu had backsets within the proposed 50 mm (2 inch) limit. Saab 9–5 rear seats also meet that proposal. For the entire fleet of new vehicles, we estimate that front seats are an average of 23 mm (0.9 inches) away from meeting the proposal and rear seats are an average of 47 mm (1.8 inches) away from the proposal. These fleet estimates were derived by using the sales weighted averages of the 14 MY 1999 vehicles measured. More details can be found in the PEA for this proposed rule.

Further, based on IIHS' rating of head restraints in MY 1999 vehicles, it appears that there are at least some models in all classes of vehicles that already meet or come close to meeting the proposed backset limit. As noted above, IIHS rates the backset of a vehicle's head restraints as good if it is not more than 70 mm (2.6 inches). According to IIHS, cars with head restraints rated good overall (i.e., both backset and height) include the BMW Z3 Coupe, Saab 9–3 and 9–5, Volkswagen New Beetle (some seat options), and Volvo C70/S70/V70 and S80 models. Among pickups, the Chevrolet S10 and GMC Sonoma have good restraints. And among utility vehicles, the Chevrolet Blazer (some seat options) and Mitsubishi Montero earn good ratings.

Nonetheless, NHTSA solicits comments on whether this proposed backset limitation is appropriate. In particular, the agency seeks information and comments on:

3. Whether limiting backset to 50 mm (2 inches) is sufficient to prevent excessive relative motion between the occupant's head and torso. Does 50 mm (2 inches) of backset provide sufficient head clearance and comfort for most occupants?

4. Would it be appropriate to allow a greater maximum backset (e.g., 100 mm (4 inches)) while requiring that head restraints with more than 50 mm (2 inches) of backset be adjustable so that backset can be reduced to 50 mm (2 inches)? Please provide data on the amount of safety disbenefit that would be associated with allowing a backset of 75 or 100 mm (3 or 4 inches), instead of 50 mm (2 inches).

NHTSA is proposing that compliance with the backset requirement be measured through use of the ICBC Head Restraint Measuring Device. Under the proposed rule, all outboard seat head restraints must have a backset of not more than 50 mm (2 inches). This 50 mm (2 inches) backset must not be exceeded at any height between 750–800 mm (29.5–31.5 inches). Although no height adjustment beyond 750 mm (29.5 inches) is required for rear seats, if these higher height positions exist, backset must be limited to 50 mm (2 inches). Figure E is a graph of the zones of adjustment for front and rear head restraints relative to the head C.G. of a 50th and 95th percentile male dummy. These positions are based on the assumptions stated in Section IV.A., Height Requirements and shown in Figures C and D.

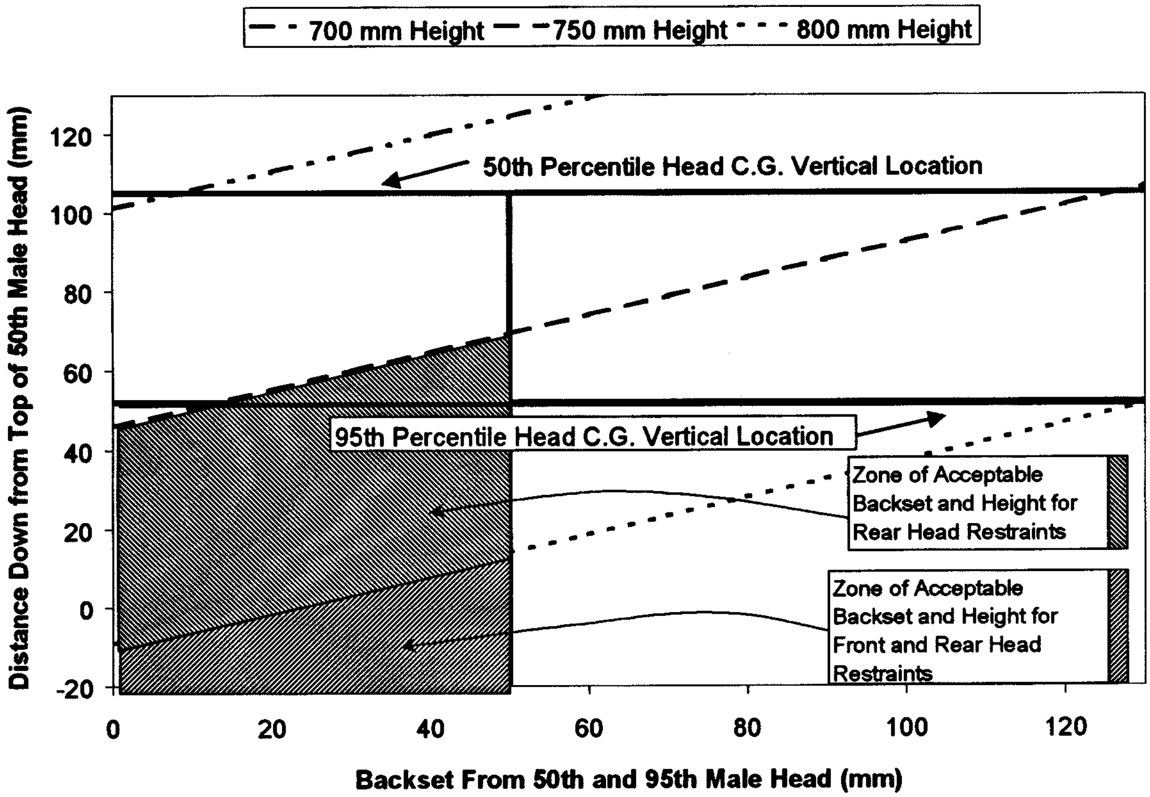

Figure E - Proposed limits on head restraint position for all outboard head restraints relative to 50th and 95th percentile dummy head C.G.

The agency believes that the ICBC measuring device is an appropriate tool for measuring backset. However, the agency solicits comments on:

5. Other devices that may be used to perform the same function as the ICBC device and whether such devices would be more appropriate.

NHTSA observes that the ECE 25 requirements do not include a specification for backset. The agency believes, however, that the proposed backset requirement, which the agency believes offers significant safety benefits, would not prevent manufacturers from producing designs meeting ECE 25.

Both the height and backset measurements are accomplished through the use of the SAE J826 manikin (June 1992) or H-point machine. The positioning procedure for this device is explicitly defined in SAE J826 in order to maximize repeatability. This in turn maximizes the repeatability of the height and backset measurements.

C. Height Adjustment and Backset Limit Retention Requirements

The agency is also proposing, for vehicles produced on or after the first occurrence of September 1, three years after publication of the final rule, that performance requirements for adjustable head restraints be added to Standard 202 which are intended to assure that the front head restraints remain locked in specific positions. A 1982 NHTSA study found that the effectiveness of integral head restraints was greater than adjustable head restraints. The study concluded that this difference in effectiveness was due, in part, to adjustable head restraints not being properly positioned. Although one reason for improper positioning is a lack of understanding on the part of the occupant on where to place the head restraint, it also could be due to the head restraint's moving out of position either during normal vehicle use or in a crash. Adjustment locks can mitigate this problem by helping to retain the adjusted position. IIHS has also been critical of adjustable head restraints, especially when they do not provide locks, in their evaluation of head restraints. This criticism has manifested itself in that IIHS, in its rating of head restraints, automatically gave adjustable restraints a lower rating on the assumption that these restraints would not be properly adjusted. In addition, it only evaluated adjustable head restraints without locks in their lowest position. In comments on the agency's 1996 technical report, Advocates stated that adjustable restraints should be required to lock. Toyota also stated that, at a minimum, head restraints should lock vertically.

The modifications to the existing height requirements and the addition of a backset requirement that are now being proposed are expected to improve the performance of all adjustable head restraints. The performance of adjustable head restraints may be further improved if steps are taken to ensure that a restraint remains in position after it has been set by the user.

In making this proposal, the agency has no desire to require specific methods for adjustment and locking. A typical adjustable head restraint design allows manual adjustment by sliding the head restraint in and out of the seat back on posts attached to the head restraint. Position locking is achieved by notches in the shaft allowing for a detent mechanism. There are also powered adjustable head restraints which are infinitely adjustable within a specific range. When the adjustment mechanism is inactive, the head restraint is, in effect, locked in position. Under the current proposal, these and other locking methods would be permissible as long as the performance criteria below are met.

Therefore, we are proposing that adjustable head restraints for the front outboard seating positions must maintain their height (i.e., lock) in several height positions under application of a downward force. In addition to locking at a position of not less than 800 mm (31.5 inches), they must also lock at the highest adjustment positions. It may be that, for some designs, the highest position is at 800 mm (31.5 inches). Adjustable head restraints for the rear outboard seating positions must lock at the highest position of adjustment above 750 mm (29.5 inches), if this position exists. In addition to locking at these specified positions of height adjustment, both front and rear head restraints must be capable of retaining the minimum height of 750 mm (29.5 inches) under application of a downward force.

The height position retention requirements must be met at any backset position of adjustment. The agency believes that this is important for designs which adjust vertically as well as rotate for backset adjustment. Although there may be no backset position more than 50 mm (2 inches), a change in the backset position may change the height of the head restraint.

We are also proposing to adopt the following backset retention requirement. Under application of a rearward moment, with the head restraint adjusted to 800 mm (31.5 inches) for front outboard seats and 750 mm (29.5 inches) for rear outboard seats, the head restraint must maintain any position of backset adjustment.

The agency believes that the proposed height and backset position retention requirements are very comprehensive and that requirements for other positions than those mentioned above are unnecessary and would not result in significant additional safety benefits. The agency notes, however, that manufacturers would not be precluded from providing additional lockable positions within the range of the head restraint's adjustment.

The proposed height adjustment retention lock and backset limiter compliance tests begin by applying a small initial load to the head restraint. A headform is used to apply the load and a reference position is recorded. The head form reference position is measured with this load applied to eliminate variability associated with the soft upholstery of the head restraint. A larger load is then applied through the headform to test the locking mechanism. Finally, the load is then reduced to the initial value and the head form is checked against its initial position. In order to comply, the locking and limiter mechanisms must not have allowed the headform to have moved more than 10 mm (0.4 inches) from the initial reference position. First, to test the vertical lock, a load is of 500 N (112 pounds) is applied vertically downward. Then, to test the backset limiter, a force is applied sufficient to generate a 373 Nm moment (3,300 inch-pounds) perpendicular and rearward to the torso reference line about the H-point. A force of approximately 500 N (112 pounds) is required to generate this moment. The agency has reviewed upper neck shear loading from 33 rigid moving barrier, rear impact (48 kph (30 mph)) FMVSS 301 tests and found the average maximum load caused by the head being loaded in the forward direction with respect to the torso is 351 N (78.9 pounds). This direction of shear load is a good indicator of head restraint loading on the head and, therefore, head loading on the head restraint. Thus, the 373 Nm (3,300 inch-pounds) rearward moment and 500 N (112) downward force are representative of the peak loads likely to be encountered in moderate to severe rear impacts.

NHTSA remains concerned, however, that while the addition of the proposed locking and limiter requirements will help ensure that properly adjusted head restraint remain in position, the requirements cannot do anything to ensure that adjustable head restraints are actually put in that position in the first place. The agency requests comments on:

6. The appropriateness of the load values used to assess the position retention capability of head restraints. Should other height and adjustment positions such as a mid-height position be tested and/or required?

7. Do vehicle users understand how to properly adjust head restraints? If not, should manufacturers be required to provide information on this subject to consumers in the vehicle owner's manual or elsewhere?

8. The extent to which misadjustment of head restraints is due to the absence of adjustment retention locks versus intentional misadjustment by occupants.

9. Do vehicle users intentionally misadjust head restraints for reasons related to comfort, visibility, or other factors?

10. Are adjustable head restraints with adjustment retention locks significantly less likely to be misadjusted than ones without such locks?

11. Would equipping restraints with locks discourage misadjustment? If not, should other requirements be adopted to address the problem of misadjustment? The agency has previously addressed issues of misuse, non-use and adjustment in several contexts, including manual seat belts and child seats. Would the measure adopted in these contexts be appropriate with respect to head restraints?

12. What would the costs and benefits be of requiring that the height of front seat head restraints be fixed at 800 mm (31.5 inches) or at some other single height? What would the costs and benefits be of adopting such a fixed head restraint requirement for rear seat head restraints?

D. Rear Outboard Seating Positions

In addition to modifying requirements for head restraints for front outboard seating positions, NHTSA is also proposing to add head restraint requirements for rear outboard seating positions for vehicles produced on or after the first September 1 that occurs three years after publication of the final rule. The agency has tentatively concluded that the addition of head restraints for these seating positions would reduce whiplash injuries to rear seat occupants and harmonize Standard 202 with the ECE 25 head restraint requirements. Data obtained from NASS for non-rollover towaway rear crashes for passenger cars and LTV's for the years 1988 through 1996 shows that there were 5,440 whiplash injuries reported annually for occupants of rear outboard seating positions.

The whiplash rate (number of occupants with whiplash divided by the number in crashes) for these seating positions is less than that for front outboard seating positions, but is still significant. The reasons for a lower rear seat whiplash rate are not clear, but probably cannot be attributed solely to the fact that rear seat occupants are on average shorter than front seat occupants. Occupants may sit differently in rear seats—their posture may place the head closer to the head restraint and reduce or eliminate backset. Although rear seat head restraints are on average 33 mm (1.3 inches) lower than front seat head restraints, the reason for the relatively low occurrence of whiplash in rear seats may be the existing configuration of rear seats and rear seat head restraints.

NHTSA is proposing that rear outboard seat head restraints must have a minimum height of 750 mm (29.5 inches) above the H-point. As noted above in the backset requirement section, the rear outboard head restraints must also meet backset requirements and have a backset of 50 mm (2 inches) or less.

NHTSA sampled the head restraint heights and backsets of 12 1999 MY vehicles which had front and rear head restraints. Three of the vehicles had rear seats of sufficient height and one vehicle met the backset limit proposed for rear seats. One of the twelve vehicles would meet both the height and backset proposal.

The agency's proposal to require head restraints in the rear outboard seating positions is, in part, based on a philosophy that commonly used seating positions should offer similar levels of protection to their occupants. This philosophy has guided the agency in requiring a test dummy to be placed in the rear seat for the dynamic performance test in FMVSS 214; *Side Impact Protection,* and in the provision of FMVSS 208; *Occupant Crash Protection,* requiring lap/shoulder seat belts to be installed in forward facing rear outboard seating positions. In establishing the FMVSS 208 and 214 requirements for both front and rear seats, we realized that, because of the significantly lower rear seat occupancy rates, the ratio of cost to benefit was inherently higher than similar front seating position requirements. In this case, there are again lesser safety benefits from rear seat head restraint protection because of lower rear seat occupancy rates. However, when people are sitting in the rear seat, they will gain safety benefits from improved head restraints.

Assessment of the relative merits of requiring enhanced protection for rear seats must also reflect the fact that NHTSA has recommended that all children 12 and under sit in the rear. Given that we have provided this advice to parents, NHTSA feels particularly obligated to provide similar levels of protection in the rear. Older children are large enough to benefit from a rear seat head restraint particularly in family vehicles with bench type seats such as minivans and SUVs. Also, rear seat occupancy should rise as more children sit there, thereby increasing the at-risk population and the corresponding benefits of rear seat head restraints. For these reasons, we have decided to propose upgrading whiplash protection in outboard rear seats notwithstanding lower cost-effectiveness for improved head restraints at those positions. NHTSA is especially interested in public comments on this approach.

The agency is not proposing to require front or rear center seat head restraints because of significant costs, much higher cost per equivalent fatality than outboard positions, and visibility concerns. The combined total cost of front and rear center seats head restraints would be $52 million (front) + $94 million (rear) = $146 million. We estimate that this substantial investment would result in reducing the annual number of whiplash injuries in the front center seat by 440 and in the rear center seat by 1,276. The combination of these cost and benefit figures would be a cost per equivalent life saved (at 7 percent discount) of $52 million for front center seat head restraints, based on the effectiveness for increasing the height of head restraints and assuming no benefit for backset. For rear center seat head restraints, the cost would be $33 million. For both front and rear center seats combined, the cost per equivalent life saved would be $38 million. All of those figures are much higher than the cost per equivalent life saved for front outboard seats ($3 million) and that for rear outboard seats ($9 million).

Finally, having center seat head restraints limits to some extent the driver's ability to see following traffic using the inside rearview mirror. When a vehicle is in reverse, front and rear center head restraints limit visibility when the driver turns his/her head to back up. In addition, a front center seat head restraint can limit vision through the right side second seat window when the driver is considering a lane change maneuver to the right. The agency can not quantify these potential losses in visibility, nor the potential impact that this loss in visibility could have on safety.

The agency is aware of rear seat head restraint designs which have the goal of lessening the rearview obstruction. Some designs provide open areas in the head restraint so the driver can see through them. Other head restraints fold out of the way into non-use positions. The agency's current proposal does not contain any requirements to specifically compensate for the potential rearview obstruction. However, the agency is proposing language in S4.3 which will allow for folding or retractable head restraints for rear seats if they meet specific criteria. If such a head restraint is adjusted to a non-use position, i.e., any position in which its minimum height is less than that proposed in this document or in which its backset is more than that proposed in this document, it must give the occupant an unambiguous physical cue that the head restraint is not properly positioned by altering the normal torso angle of the occupant or it must automatically return to a position where it would comply with all provisions of the regulation when the seat is occupied. To determine if the head restraint in a non-use position alters the torso angle of an occupant, the SAE J826 manikin is placed in the seat position. The torso angle of the manikin when the head restraint is in a non-use position must be at least 10 degrees closer to the vertical than when the head restraint is in a normal use position. Alternately, if the head restraint is designed to return automatically from a non-use position to a normal use position, this must occur when a 5th female and 50th male Hybrid III test dummy in placed in the seating position.

The agency would like commenters to address the issues surrounding rear seat head restraints and their impact on rearward visibility. Specifically, the agency would like to know the following:

13. Are data available related to safety risks, if any, associated with decreased visibility caused by rear seat head restraints?

14. Should the agency place specific design requirements on rear seat head restraints to compensate for any potential visibility losses?

15. Should Standard 202 allow rear head restraints to have non-use positions? If so, how should such positions be defined and limited?

16. Are the proposed requirements for non-use positions sufficiently objective? Are they sufficient to alert occupants that the head restraint is not in a normal use position?

17. Given the lesser safety from rear seat head restraint protection because of lower rear seat occupancy rates, and given the visibility issues, should the agency limit the application of any final rule to front seating positions?

An additional concern raised by the required installation of outboard rear seat head restraints is the impact of such restraints on child restraints that use top mounted tether straps. The agency notes that tethered child restraint requirements have just been instituted in the United States and have been required for some time in Canada and Australia—where vehicles with rear head restraints are relatively common. Inquiries to Transport Canada, NHTSA's Canadian counterpart, indicate that interference between rear head restraints and child seat tethers has not posed significant problems. NHTSA also wishes to point out that on March 5, 1999, the agency published the final rule for Standard 225, "Child Restraint Anchorage System" (64 FR 10785). The standard requires an independent system which has two lower anchorages, and one upper anchorage. Each lower anchorage includes a rigid round rod or bar onto which a hook, a jaw-like buckle or other connector can be snapped. The bars will be located near the intersection of the vehicle seat cushion and seat back. The upper anchorage will be a ring-like object to which the upper tether of a child restraint system can be attached.

In its examination of the potential for interference between tethers and rear seat head restraints conducted prior to the issuance of that final rule, the agency agreed that compatibility problems between the tether and rear seat head restraints could occur in some situations but concluded that this did not present an unsurmountable design problem. NHTSA concluded that ''Y'' shaped tether strap designs that encircle the head restraint might be used where the tether could not pass over or under the head restraint. Furthermore, as the final rule amending Standard 213, ''Child Restraint Systems,'' requires the use of a fixture for testing tether strength, manufacturers should be able to identify and correct for potential compatibility problems between the tether system and head restraints.

Nonetheless, the agency solicits comments on the following:

18. Are there potential safety concerns caused by interference between rear seat head restraints and child seat tethers?

19. The existence or significance of test data showing whether passing the top tether over the top of the head restraint or underneath an adjustable head restraint has any effect on head excursion or lateral stability of a child restraint.

E. Removability of Head Restraints

The agency is aware that some current head restraints, both front and rear, can be manually removed solely by hand (*i.e.,* without the assistance of any hand held object). Such a design is not currently prohibited by Standard 202. The agency believes strongly that all occupied outboard seats should have a properly positioned head restraint in place. However, for seats which are often unoccupied, which is usually the case for rear seats, there may be a potential benefit to allow head restraints to be removable for the sake of increasing a driver's field of view towards the rear. The proposed rule would prohibit removable head restraints in the front seats, but would not prohibit removable head restraints in the rear seats. The agency believes that a rear seat which has its head restraint removed gives a strong visual cue to a prospective occupant unlike a head restraint which may be in a subtle non-use position. Front seats must be designed so that they cannot be removed solely by hand.

20. Should Standard 202 continue to allow any head restraints to be removable by hand? If so, should this be limited to rear seat head restraints?

21. Should there be some type of indicator to warn a prospective occupant that the head restraint has been removed, or is the visual cue of a seat without a head restraint sufficient?

F. Head Restraint Configuration Requirements

1. Width

NHTSA has tentatively concluded that the requirements for head restraints on vehicles produced on or after the first occurrence of September 1, three years after publication of the final rule, should maintain the existing width requirements contained in Standard 202. These provisions require that head restraints be at least 170 mm (6.7 inches) wide on single seats and 254 mm (10 inches) wide on bench seats. The agency believes that doing otherwise will degrade the level of safety currently available. Occupants seated on bench seats are freer than occupants of single seats to position themselves so that they are not directly in front of the head restraint. This is especially true if they do not use their seat belts—a concern that is more relevant in the United States than in Europe. Thus, the head restraint needs to be wider to assure that, in the event of a crash, the head restraint will be positioned behind an occupant's head.

This proposal differs from the ECE 25 regulations in specifying a different width requirement for bench seats than for other seats. As noted above, the agency is concerned that because seats other than bucket seats, i.e., bench and split bench seats, are more widely used in the United States than in Europe, Standard 202 should dictate different width requirements than those found in ECE 25.

2. Gaps

NHTSA is proposing the addition of maximum gap requirements for head restraint designs incorporating openings within the perimeter of the restraint. Gaps may be provided to allow for sight through the head restraint. However, gaps which are too large may defeat the purpose of the head restraint by allowing the head to displace too far before contact with the head restraint. The agency used ECE 25 as a model for the gap requirement in the NPRM. The agency proposal for integral restraints allows a maximum 60 mm (2.36 inches) gap in the head restraint and an identical maximum gap between the head restraint and seat. For height adjustable head restraints, 60 mm (2.36 inches) gaps are allowed in the head restraint. When adjustable head restraints are in their lowest position they must have some position of backset adjustment where the gap between the seat and head restraint is less than 25 mm (1 inch). However, this gap cannot be greater than 60 mm (2.36 inches). The agency believes that a 25 mm (1 inch) gap requirement between the seat and head restraint would essentially require the seat back to provide the travel stop for head restraint adjustment downward. This would eliminate significant discontinuities between the seat back and head restraint when the head restraint is in its lowest position, which may be a benefit to short occupants. The maximum 60 mm (2.36 inches) gap between the seat back and head restraint when the head restraint is in the lowest adjustment position is allowed in anticipation of designs that have rotational backset adjustment. It may not be possible for this type of design to meet the 25 mm (1 inch) limit in all rotational positions.

Finally, it should be noted that the gap requirements would place no limit on the size of the gap between the seat back and head restraint that is produced when the head restraint is raised. The establishment of such a limit would eliminate from the market place most existing adjustable head restraints. The agency anticipates that occupants will not adjust their head restraints such that the rear portion of their head would be between the top of the seat and bottom of the head restraint. Nonetheless, the agency would like comments on this issue.

For harmonization purposes, NHTSA notes that the proposed gap requirements are identical to the ECE 25 specifications with two exceptions. First, the proposed NHTSA limit on the distance between the head restraint and the seat when the head restraint is in its lowest position applies only at a single position of backset adjustment. The ECE requirement does not contemplate head restraints that may be adjustable for backset and simply allows no more than a 25 mm (1 inch) gap. Second, the ECE standard allows an alternate compliance option of application of a load to the gap area rather than limiting the gap to 60 mm (2.36 inches). The agency assumes that the concept behind this option is that if pushing on the gap area with a head form does not cause deflection of more than 102 mm (4 inches), the gap is acceptable. The agency sees no need for permitting this alternate method of compliance.

22. The agency requests comments on the need for a requirement limiting the gap between the lower edge of an adjustable head restraint and the seat to 25 mm (1 inch) when the restraint is in its lowest position.

23. NHTSA requests comments on whether 60 mm (2.36 inches) is an appropriate value for the maximum size of the gap between a seat and the lower edge of an integral head restraint and the maximum allowable gap in any head restraint.

24. The agency also requests comments on whether a limit should be placed on the gap

between adjustable head restraints and the seat back when the head restrain is in a raised position.

G. Energy Absorption

For vehicles produced on or after the first occurrence of September 1, three years after publication of the final rule, the agency is also proposing an energy absorption requirement specifying that when the front of the head restraint is impacted by a head form at a velocity of 24.1 kilometers per hour (15 mph), the deceleration of the head form must not exceed 80g continuously for more than 3 milliseconds. The impactor would be a free-motion head form with a 6.8 kg (15 pound) mass. The proposal would require the head restraint to comply in any position of adjustment. The area of the head restraint subject to impact in the compliance test would differ depending on the seat configuration. The proposal limits this area to within 70 mm (2.8 inches) of the head restraint vertical centerline for single seats, but increases the impact area to within 105 mm (4.1 inches) of the centerline for bench seats because of the potential for occupants to be seated farther from the centerline in bench seats. The point of impact must be at least 635 mm (25 inches) above the H-point.

The agency proposal is similar, but not identical, to the requirements of ECE 25. ECE 25 requires the use of a pendulum impactor. The agency's proposal specifies the use of a free-motion head form impactor. NHTSA believes the results from a pendulum or head form impactor would be the same. In order to increase the level of harmonization with ECE 25, the agency is not at this time proposing the use of the free-motion head form in Part 572 Subpart L. This head form is required for upper interior impacts in Standard 201; Occupant Protection in Interior Impacts. The Part 572(L) head form has a 4.5 kg mass (10 pound) rather than a 6.8 kg (15 pound) mass. However the mass and impact speed of the head form in ECE 25 and being proposed here are the same as required by Section 5 of Standard 201.

The agency proposal also differs from ECE 25 in the dimensions of the area of impact. ECE 25 specifies a single size for the impact area regardless of the seat configuration. As bench seating is more common in vehicles produced for the North American market, the agency believes that the variance between the two regulations is justified.

The proposal also contains a minimum radius of curvature requirement for the front surface of the head restraint. In order to protect rear seat occupants from injuries caused by impact with the head restraint in frontal crashes and all occupants in rollovers or similar crashes, any part of the head restraint outside of the impact zone for the energy absorption requirement must not have a radius smaller than 5 mm (0.2 inches) unless it can pass the energy absorption requirement. This requirement is intended to eliminate potential sources of high pressure contacts between occupants and head restraints. NHTSA is not aware of any surfaces on current head restraint designs that have such a small radius of curvature and believes that most, if not all, would be in compliance. Nonetheless, NHTSA is proposing this requirement in the interest of increasing the level of harmonization with ECE 25.

25. The agency requests comment on the need for the requirement for limiting the radius of curvature outside of the impact zone to no less than 5 mm (0.2 inches).

26. NHTSA would also like comments whether the Part 572 Subpart L free-motion head form should be proposed rather than the head form in the current proposal which more closely harmonizes with ECE 25.

H. Test Procedures

1. Displacement Test Procedure

The agency is also proposing changes to the existing displacement test procedure contained in Standard 202. In this procedure, the head restraint's ability to resist deflection is measured by applying a load to the back pan of the seat and applying a load to the head restraint after the load on the back pan of the seat is released. A 102 mm (4 inch) displacement is allowed with a 373 Nm (3,300 inch-pounds) moment applied. The applied load is then increased until the seat or seat back fails or the load reaches 890 N (200 pounds) and the head restraint withstands this load.

The proposal modifies this test procedure to require that the back pan of the seat and the head restraint be subjected to simultaneous loading. The agency proposal also removes the current standard's provision allowing seats or seat backs to fail when the head restraint is subjected to the 890 N (200 pounds) load. Lastly, the proposal modifies the existing test procedure to clarify the direction of the loads placed on the restraint, seat and seat back. The proposal maintains the 4 inch displacement limit. The exact SI conversion to 102 mm is used rather than rounding the value to 100 mm because it is an existing requirement.

Data provided by the AAMA and AIAM indicate that loading the seat back pan and the head restraint at the same time results in a more severe test. These data were contained in a petition submitted to the agency in support of harmonizing the existing Standard 202 test with the ECE 25 test. AAMA/AIAM provided data from one 1998 model year vehicle seat that showed a 64 mm (2.5 inch) displacement for the Standard 202 method and a 89 mm (3.5 inch) displacement for the ECE method. NHTSA's review of the AAMA/AIAM data indicates that the AAMA/AIAM position appears to be correct. Because the back pan position is maintained while the head restraint is loaded, some amount of load may be applied through the back pan to the seat. This load, along with the load applied to the head restraint, results in the total applied seat moment and contributes to head restraint deflection. Thus, the head restraint deflection may be greater than if the back pan load is removed before application of the head restraint load. The agency believes that applying loads to both the back pan and the head restraint simultaneously better reflects the stresses that occur in rear end crashes.

This change, if adopted, will harmonize the Standard 202 displacement test procedure with that contained in the ECE 25 regulation. In both test procedures, the back pan of the SAE J826 test device is used to apply a 373 Nm (3,300 inch-pounds) moment to the seat back. Currently, the difference in the two test procedures is that Standard 202 specifies that the back pan load is removed before application of the moment to the head restraint and ECE 25 specifies that the back pan position is maintained while the head restraint moment is applied.

Additional text has been added to the displacement test procedure to clarify the direction of loading on the head restraint and seat back. The proposal would require that the back pan be constrained so that as pressure is applied, it rotates about the H-point and the moment producing force, which is initially perpendicular to the torso line, rotates with the back pan. However, the proposal also would require that the moment-producing force on the head restraint initially be applied perpendicular to the displaced torso reference line and that the orientation be maintained with respect to the ground throughout the testing.

Finally, the existing displacement procedure allows the seat back to fail without consequence under application of 890 N (200 pounds) to the head restraint. Yet, from the perspective of an occupant, if the head restraint is displaced during loading, the consequences may be equally severe regardless of the reason for the displacement. Therefore, the NPRM removes the allowance for seat back failure. The head restraint must be able to apply a resistive force of 890 N (200 pounds) to the load applying head form. If the head restraint is displaced out of the path of the head form prior to achievement of the 890 N (200 pounds) load, the head restraint has failed, regardless of whether failure was due to weakness in the seat or the head restraint components.

2. Dynamic Sled Test Procedure

The agency is also proposing changes to the existing Standard 202 dynamic test option. Currently, Standard 202's dynamic compliance option specifies that the seat structure must be accelerated such that the acceleration pulse lies between two half sine waves. The lower boundary half sine wave is represented by the expression a = 78 Sin(πt/80) and the upper boundary is represented by a = 94 Sin(πt/96), where t is in milliseconds and a has the units of m/s^2. Figure F shows these sled pulse boundaries along with the target sled pulse between them (represented by a = 86 Sin(πt/88)). It can be seen from this figure that at the beginning of the pulse there is very little area in the corridor. NHTSA believes that as a practical matter the existing corridor cannot be met. For this reason, a new sled pulse corridor has been developed. Its dimensions are derived from a scaled down corridor now used in the FMVSS 208 sled test procedure. The new corridor is wider than the existing corridor until about 40 ms and narrower from about 60 ms on. However, the target sled pulse remains the same.

In addition to modifying the corridor shape, we have revised the test procedure to specify that the vehicle, instead of simply the seat, is mounted on the sled. The agency believes this is necessary because both front and rear seats are now required to have head restraints and could be dynamically tested. This also simplifies the test setup because the dummies are required to be restrained by a Type 2 belt which is often attached to the B-pillar. The agency believes existing sled designs can stay within the specified acceleration corridor with a vehicle mounted to them. Finally, SAE J211/1 (March 1995) has been referenced to indicate the use of channel filter class (CFC) 60 for data processing.

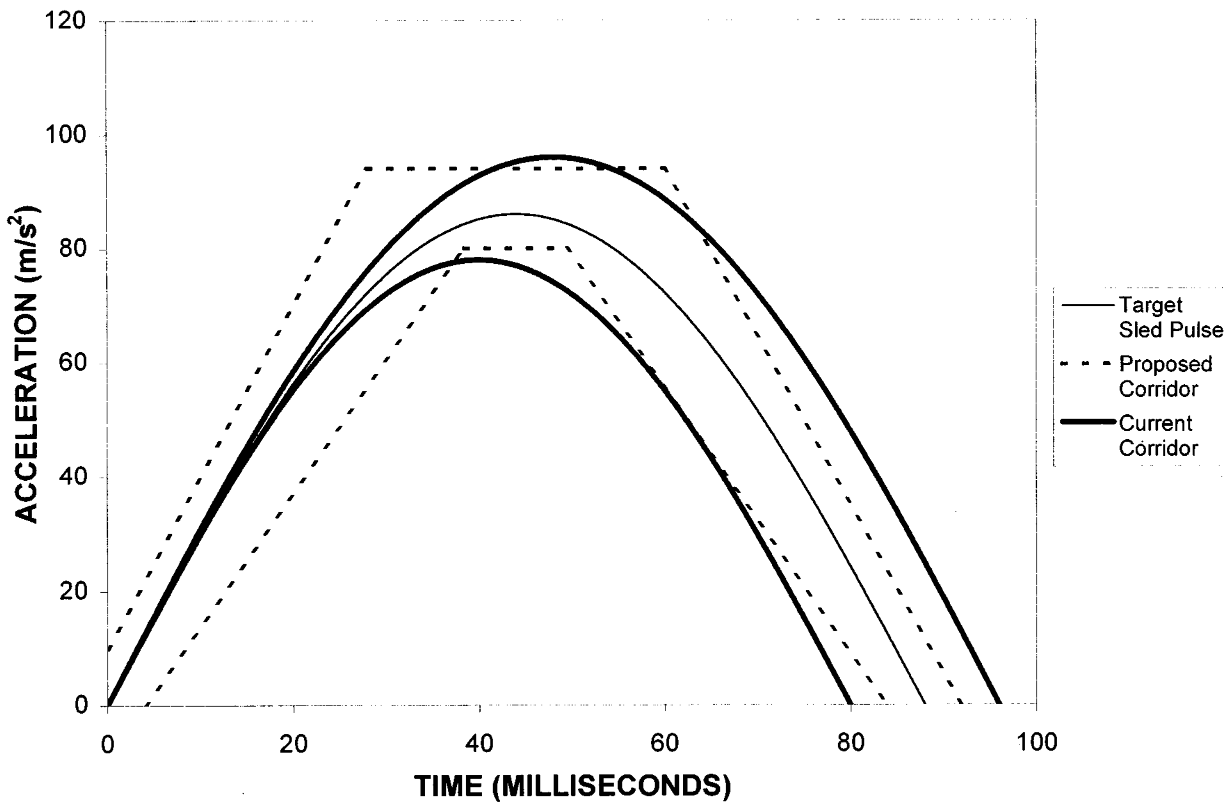

Figure F - Current and proposed sled pulse corridors for the dynamic compliance options of Standard 202.

The agency is also proposing to alter the performance requirements for the dynamic compliance test option due to the proposal's alteration of the existing head restraint height requirements. The current dynamic test accelerates a seat loaded with a 95th percentile dummy to an 8g half sine acceleration pulse over 80 ms. In order to pass this test, the dummy neck must not rotate rearward with respect to the torso more than 45 degrees. The 45 degree performance limit was developed such that a 700 mm (27.5 inch) high head restraint would pass the dynamic test.

The proposal also alters the specifications for one aspect of the seating procedure for the dynamic test. Standard 202 currently specifies that the test device shall be secured by a Type 1 seat belt in the design seating position of each designated seating position with a head restraint. The proposal changes this requirement by substituting a Type 2 seat belt for a Type 1. This change is being instituted to more accurately reflect current requirements for the installation of Type 2 belts in outboard seating positions.

If the agency's proposal did not alter the dummy head rotation requirement, manufacturers could pass the standard using the dynamic test with 700 mm (27.5 inch) high head restraints even though the new proposed minimum height requirement is 750 mm (29.5 inches). To avoid this, we are proposing to alter the dynamic test procedure and injury criteria for front outboard seating positions so that when the 95th percentile male test dummy is used, only head restraints at least 800 mm (31.5 inches) high with a maximum 50 mm (2 inch) backset could pass. We are also proposing requirements using a 50th percentile male test dummy at all outboard seating positions.

In their comments to the agencies 1996 Technical Report discussed in Section II.B, Volvo favored the elimination of the dynamic test option. It believed that there was insufficient knowledge about injury mechanisms and that test dummies needed to be improved. However, Volvo has developed a seat design to specifically reduce whiplash injuries, indicating that it believes that it has enough knowledge to change the way it designs seats. In their comments to the Technical Report, Chalmers supported a dynamic test using either a BioRID or Hybrid III dummy and suggested that the Neck Injury Criterion (NIC) be used to evaluate performance. Chalmers also believes a dynamic test procedure is needed to measure the performance of active head restraints.

There are several reasons why the agency does not wish to eliminate the dynamic compliance option. Some of these became apparent when NHTSA proposed deleting this option in 1995. In October 1995, under the ''Regulatory Reinvention Initiative,'' the agency published an NPRM which proposed to eliminate the dynamic options because it believed neither manufacturers nor the agency used this option to determine compliance. Comments on the Reinvention NPRM by vehicle manufacturers favored deleting the options, but Advocates and recreational vehicle (RV) manufacturers and a seat supplier opposed the deletion because it would limit compliance options.

IIHS wanted to keep the dynamic test because not having it might limit the development of active head restraint systems designed to deploy upon rear impact. For example, as noted above, the Saab 9–5 is equipped with active head restraints which operate by use of a lever.[14] We measured a head restraint in a MY 1999 model 9–5 to determine its height and backset. It meets the current height requirement by 95 mm (3.8 inches). Therefore, there is no need for the manufacturer to certify to the current dynamic compliance option. However, the current design would not meet the requirements in this proposal by 6 mm (0.3 inches). However, if the proposed requirements were in place, the manufacturer could choose to certify to the dynamic compliance option.

NHTSA believes that the dynamic test option should be retained and upgraded. The dynamic test option provides the means to assess the many seat design parameters which affect whiplash reduction. However, as it is clear that limiting hyperextension alone does not prevent whiplash injury, the agency proposes to modify the dynamic test procedure by adopting new performance values of relative head-to-torso rearward rotation for determining compliance with Standard 202. The proposed performance requirement for front seating positions is a maximum of 12 degrees of relative head-to-torso rotation with the 50th percentile dummy and a maximum of 20 degrees of head-to-torso rotation with a 95th percentile dummy. For rear seating positions no more than 12 degrees of head-to-torso rotation is permissible with a 50th percentile dummy as the measurement device. The current standard allows head-to-torso rotation of 45 degrees with a 95th percentile dummy for the front seating positions and does not regulate the rear seating positions.

The proposed values were selected to be consistent with the height and backset requirements in the proposed static compliance option. The head restraints would need to comply at any position of height and backset adjustment when the 50th percentile dummy is used in the front and rear seats. The manufacturer would have the option of selecting a single height position for the 95th percentile dummy in the front seats. The key testing parameters associated with each seating position are shown in Table 3.

TABLE 3.—PROPOSED TESTING PARAMETERS FOR EACH SEATING POSITION FOR THE DYNAMIC COMPLIANCE OPTION

Seating position	Dummy size	Rotation limit (deg.)	Head restraint adjustment	
			Backset	Height
Front	50th male	12	Any	Any
Front	95th male	20	Any	One *
Rear	50th male	12	Any	Any

* Position selected at the manufacturer's option.

The criteria were developed primarily through sled testing of a modified production vehicle seat. A preliminary report on the experimental results is available in the docket for this notice. The seat used was not optimized to limit head rotation, but was modified to allow positioning of the head restraint to specified locations and stiffened to eliminate seat back rotation with respect to the seat base. Stiffening of the seat back was believed to create a worst case situation for head rotation. Table 4 shows the rearward angular head-to-torso rotation of a 50th and 95th percentile Hybrid III dummy when exposed to a sled acceleration such that the change in velocity was about 20—25 percent greater than that in both the current and proposed regulation. Rotation was not measured beyond 200

[14] The Saab active head restraint is purely mechanical. When the vehicle is struck from the rear (at speeds equivalent to 16 km/h or greater in a crash involving a barrier), the driver and front seat passenger's bodies move rearward into the seat cushion. A padded pressure plate is moved rearward as a result, and through a linkage moves the head restraint upwards and forward to support the head. The precise activation of the system is determined by the force with which the driver or passenger's back is propelled against the backrest, the magnitude of the crash forces and the occupant's weight.

milliseconds because the dummy torso has rebounded away from the seat at that point in time. The backset values listed were as measured by the ICBC device prior to testing.

TABLE 4.—50TH AND 95TH PERCENTILE MALE HYBRID III DUMMY MAXIMUM HEAD-TO-TORSO ROTATION (DEG.) AS A FUNCTION OF HEAD RESTRAINT BACKSET AND HEIGHT

Height	Backset					
	0 mm (0 in.)		50 mm (2 in.)		100 mm (4 in.)	
	50th	95th	50th	95th	50th	95th
750 mm (29.5 in.)	11	*25	18	45	41	61
800 mm (31.5 in.)	*13	*20	23	34	44	56

*Maximum value prior to 200 ms after start of acceleration.

The sled test data for the 50th percentile dummy show that the 750 mm (29.5 inches) high head restraint had lower head rotation than the 800 mm (31.5 inches) high restraint. This may have been because of the shape of the head restraint caused the dummy head to contact the head restraint above the rearmost portion of the head. Thus, the tested head restraint was more optimally fit to the 50th percentile dummy head when positioned at a height of 750 mm (29.5 inches). This phenomenon illustrates why the proposed regulation would also specify the use of a 95th percentile male dummy. If only the 50th dummy were specified, complying head restraints could have heights of no more than 750 mm (29.5 inches). This would be inconsistent with the static height requirement of 800 mm (31.5 inches) for front seats. The agency believes that compliance with performance requirements with both the 50th and 95th percentile dummies is needed to assure that all occupants in the front seating positions up to and including the tallest are protected. To be consistent with the rear seat static requirement, where only a minimum height of 750 mm (29.5 inches) required, only the 50th percentile dummy is specified for rear seat dynamic compliance.

Based on the sled testing, the agency believes that head restraints 800 mm (31.5 inches) high with a backset of 50 mm (2 inches) could restrict head-to-torso rearward rotation of a 95th percentile dummy to 20 degrees in the proposed dynamic test. Similarly, head restraint at least 750 mm (29.5 inch) high with a 50 mm (2 inch) backset could restrict head-to-torso rearward rotation of a 50th percentile dummy to 12 degrees. The proposed performance values are as shown in Table 3.

In selecting performance criteria for the dynamic compliance option, the agency's goal was to provide a level of safety similar to that provided by the static requirements and provide a method of compliance appropriate for both static and active head restraint designs. Although the modified seat tested by the agency had greater head-to-torso rotation than the proposed performance values in some of the head restraint positions that are proposed for the static compliance option, the agency believes these test data provide insight into the worst case head-to-torso rotation at each head restraint position tested. As stated above, this was partially due to the rigid nature of the seat back, which provided very firm restraint to the dummy torso and therefore accentuated the effect of any gap between the dummy head and the head restraint. It was also due to the sled pulse velocity change being 20–25 percent greater than the target of 17.3 kph in about the same time period. Finally, the method used to attach the head restraint to the seat back, which in some situations allowed significant movement of the head restraint when in contact with the dummy head, added to head-to-torso rotation. As an example of this movement, when the 95th male dummy was tested at the 800 mm (31.5 inch) high and 50 mm (2 inch) backset head restraint position, the dummy head rotated an additional 10 degrees after the head restraint began to deform due to contact with the dummy head. A similar situation occurred at the 750 mm (29.5 inch) high and 50 mm (2 inch) backset head restraint position when the 50th percentile dummy was tested. Therefore, the agency believes that it would be practicable for manufacturers to achieve head-to-torso rotations below those proposed when tested within the proposed acceleration corridor.

The agency plans to perform additional sled tests before the publication of the final rule to assure that the head rotation performance values selected are appropriate.

The agency considered performance criteria other than head rotation for the dynamic compliance options. These included N_{ij}, which is a combination of upper neck moments and forces introduced in the Advanced Air Bag Rulemaking (Docket NHTSA–98–4405); NIC, which was developed by Chalmers University and has been used by IIHS in testing active head restraints; and individual values of force, moment and acceleration. In the absence of generally accepted injury criteria specifically applicable to whiplash injuries, the agency must still assume that a head restraint's ability to prevent whiplash is primarily due to its ability to prevent the rearward translation and rotation of the occupant's head with respect to the torso. The sled tests showed that rearward head rotation seemed to correlate to head restraint position. Other biomechnics researchers have found a similar correlation and used head-to-torso rotations for the evaluation of whiplash injury.[15] Such a correlation indicates there are similar safety benefits between the dynamic and static requirements of the proposed regulation. The agency is willing to reconsider the dynamic performance criteria when more advanced whiplash injury criteria become available.

The agency requests comments on:

27. Are the performance criteria and values tentatively selected for the dynamic performance option the most appropriate criteria and values?

28. Should a limit also be placed on forward head rotation or neck loading so that any potential negative effects of active head restraints would be minimized?

In the current standard the dynamic test procedure specifies only a 95th percentile dummy, but not the specific type. This proposal rectifies this ambiguity by proposing the use of the Hybrid III 50th and 95th percentile dummy. The 95th percentile male dummy is not currently incorporated in 49 CFR Part 572, *Anthropomorphic Test*

[15] Geigl *et al.* (1994) The Movement of Head and Cervical Spine During Rear-end Impact. IRCOBI, pp 127–137.

Devices. However, we anticipate issuing an NPRM to incorporate this dummy into 49 CFR Part 572 within 12 to 18 months, which will probably be several years prior to the proposed effective date of the upgraded Standard 202.

The positioning procedure for the 95th Hybrid III dummy is essentially the same as for the 50th Hybrid III except for the positioning of dummy's H-point in reference to the seat H-point. The offset specified is 9 mm (0.35 inches) above and 15 mm (0.60 inches) forward of the seat H-point.

NHTSA is aware of criticism that the 50th percentile Hybrid III neck lacks sufficient biofidelity to be a useful tool for rear impact testing and, since it is likely to be very similar in design, the same criticism could be extended to the 95th percentile dummy neck. NHTSA is also aware of a newly developed test device, BioRID,[16] which purports to more accurately models the human neck, and of a recent paper by Ford (SAE 973342) which argues that the 50th percentile Hybrid III neck is sufficiently biofidelic in the rearward direction. The agency is likely to revisit both the dynamic performance values and the proposed test device as more advanced dummies are developed and as injury criteria based on human studies achieve broader consensus. The agency would like commenters to address the following issues related to the test dummy selected for the dynamic compliance option:

29. Should the agency consider the use of the 5th percentile female in addition to the 50th and 95th percentile male dummies in the dynamic test or is it reasonable to assume that designs which are adequate for the 50th and 95th males will be adequate for the 5th female?

30. Which advanced dummy neck designs should be considered for future use in the dynamic test and are they likely to be available prior to the effective date of the proposal?

Currently, the dynamic compliance test option requires only that the head rotation criteria be met. The agency is now proposing that, in addition to head rotation, a Head Injury Criterion (HIC) (15 ms) limit of 150 must not be exceeded. We are proposing a 15 ms HIC window to be consistent with the new HIC criterion in Standard 208. The HIC level of 150 is associated with a 1.1 to 4.3 percent probability of moderate (MAIS 2+) head injury. It is the agency's view that inclusion of this requirement would serve as an equivalent to the 80g energy absorption limit found in the static test option.

NHTSA has tentatively concluded that the addition of the HIC requirement to the dynamic compliance option would not place an undue burden on manufacturers while ensuring that head restraints certified to this option have adequate impact absorption characteristics. The HIC values measured in sled testing of a modified production vehicle seat are shown in Table 5. The greatest HIC value in Table 5 is for the 50th percentile dummy with a head restraint position of 50 mm (2 inches) of backset and 750 mm (29.5 inches) of height. This HIC of 157 exceeds the proposed limit of 150. However, the sled pulse for this test had a velocity change of 4.3 kph (25 percent) greater than the proposed velocity change of 17.3 kph and, as mentioned previously the head restraint was not optimized in any way. The agency believes that for a more optimally designed head restraint tested within the proposed acceleration corridor the 150 HIC limit can be met without great difficulty and is needed to provide assurance that head restraints will be sufficiently padded.

31. The agency solicits comments on the proposed HIC 15 limit of 150. Should a different upper limit be specified? Should a 36 ms window be used? If so, should the maximum allowable HIC value be increased?

TABLE 5.—50TH AND 95TH PERCENTILE MALE HYBRID III DUMMY MAXIMUM HEAD-TO-TORSO ROTATION (DEG.) AS A FUNCTION OF HEAD RESTRAINT BACKSET AND HEIGHT

Height	Backset					
	0 mm (0 in.)		50 mm (2 in.)		100 mm (4 in.)	
	50th	95th	50th	95th	50th	95th
750 mm (29.5 in.)	11	*25	18	45	41	61
800 mm (31.5 in.)	*13	*20	23	34	44	56

The agency believes that head restraints certified to the dynamic compliance option should also be required to meet the head restraint width provisions proposed for the static test. These provisions require that head restraints be at least 170 mm (6.7 inches) wide on single seats and 254 mm (10 inches) wide on bench seats. The agency notes that because the motion of the sled used in the dynamic test is unimodal—in a single longitudinal direction—the proposed test would not address the performance of head restraints in off-axis impacts.

The proposed width requirements are the only dimensional criteria offered for inclusion in the dynamic test option. The agency believes that the gap limits proposed in the static test option are not necessary, as head rotation limits would be exceeded if gap sizes were excessive. NHTSA is, however, soliciting comments relating to certain aspects of the proposed dynamic test option:

32. Is the head restraint width requirement appropriate for the dynamic compliance option? Should any of the other dimensional requirements used in the static test option be inserted into the dynamic test requirements?

V. Interim Compliance Options Before Upgraded Requirements Become Mandatory

The August 13, 1997 petition submitted by AAMA/AIAM urged NHTSA to consider compliance with European head restraint regulations to be functionally equivalent to compliance with the current Standard 202. There are three European regulations applicable to head restraints—EEC 96/37/EU, promulgated by the European Union, and ECE 17.05, and ECE 25.04, both issued by the Economic Commission for Europe. Of these three regulations, both 96/37/EU

[16] BioRID stands for Biofidelic Rear Impact Dummy. It was developed by a consortium of Chalmers University of Technology in Sweden, Autoliv, Saab and Volvo to help safety engineers evaluate the relative motion of the head and torso in rear crashes. BioRID has a flexible spine with 24 vertebra-like segments, the same number as in the human spine. It has joints that allow for forward and backward movement of the head, and integrates spring-loaded cables that simulate the action of human neck muscles. Its spine is said to interact with vehicle seats in a more humanlike way than the Hybrid III's rigid spine. Further, its neck is capable of producing the S-shape observed in human necks during rear crashes.

and ECE 17.05 are applicable to seats and seat backs, but incorporate the head restraint provisions found in ECE 25. Each establishes a performance requirement for energy absorption which is slightly more stringent than that now in Standard 202. Further, the requirements for height, allowable gaps, rear seat head restraints, energy absorption and the procedure for rearward displacement testing are identical to those now being proposed by NHTSA for incorporation in Standard 202. However, the agency's proposal contains backset requirements and adjustment retention lock provisions not found in the European regulations and retains the existing minimum width provisions currently incorporated into Standard 202. The European regulations also do not contain a separate width requirement for bench seats found in the current version of Standard 202 and specify a slightly smaller minimum width for head restraints for non-bench seats.

NHTSA's policies and procedures for evaluating the functional equivalence of foreign safety standards are contained in Appendix B of 49 CFR Part 553, the agency's rulemaking procedures, published in the **Federal Register** on May 13, 1998 (63 FR 26508). Under the policy and procedures enunciated in that final rule, a determination by this agency that a foreign standard is functionally equivalent to a counterpart U.S. standard is dependent upon this agency's concluding that the functional performance or safety benefits associated with compliance with the foreign standard is at least as great as those associated with the current U.S. standard.

The first step in the procedures is the determination of whether the U.S. regulation and the foreign directive are intended to address the same safety problem. In the instant case, ECE 25 and Standard 202 are intended to address neck and other injuries to occupants in rear impacts. Having identified both standards as addressing the same safety need, the agency then performed further analysis.

Under the agency's procedures, the next step in evaluating functional equivalence is a comparison of the requirements, test conditions and test procedures found in the two standards. If the differences between the two standards are not insignificant, the next step involves the examination of the real world safety data to examine the relative benefits of the two standards. If this safety data show the foreign standard offers greater benefits, the agency will begin rulemaking to upgrade the U.S. standard to the level of the foreign standard or beyond. If the real world data show the performance of the two standards to be equal, the agency may initiate rulemaking to add the foreign standard as an alternative means of compliance.

NHTSA recognizes that the differences in requirements, test conditions, and test procedures between the U.S. regulation and the ECE 25 may have safety consequences. Therefore, the agency must make some effort to compare the relative benefits and effectiveness of each regulation. The preferred means of determining if foreign standard produces at least as much benefit are real world crash data from some vehicles meeting one standard and from other vehicles meeting the other standard.

When an attempt was made to examine crash data to compare the relative benefits of Standard 202 and ECE 25, NHTSA determined that the crash data available relating to the actual performance of ECE 25 was not sufficient to allow the agency to draw any meaningful conclusions. Similarly, the agency has determined that since ECE 25 and Standard 202 compliance data are primarily dimensional in nature, these data are not useful in comparing the relative safety benefits of each.

Completion of this initial phase of data analysis placed NHTSA at a major decision point in the functional equivalence process (i.e., Are there sufficient data to assess the functional equivalency of the two standards? If not, could additional research be conducted to generate data?). Rather than embarking on a research program of its own, the agency surveyed existing biomedical and safety research to determine if this information could be used to assess the relative merits of ECE 25 and the existing provisions of Standard 202.

As noted above, there is a general consensus in the safety and biomedical community that head restraints that are both higher and closer to the head offer increased protection against whiplash injuries in rear impacts. ECE 25 specifies a greater minimum height which is 50 mm (2 inches) greater than the height that must currently be achieved in Standard 202. That difference suggests that compliance with ECE 25 provides greater safety benefits than the existing provisions of Standard 202. Also, the maximum height that must be achieved in ECE 25 is 100 mm (4 inches) greater than that required by Standard 202. ECE 25 differs from the existing version of Standard 202 in ways other than height requirements. Standard 202 currently does not require head restraints for rear seating positions or contain any requirements for energy absorption. ECE 25 contains requirements for energy absorption and applies to head restraints in rear seating positions.

Therefore, the agency has tentatively concluded that ECE 25 offers greater safety benefits than the existing version of Standard 202 under the functional equivalence process defined in Part 553, Appendix B. Therefore, the agency is proposing that in the period between 90 days following the publication of any final rule that is derived from this proposal and the first occurrence of September 1, three years after publication of the final rule (the date on which new cars must meet the upgraded Standard 202 requirements), manufacturers may certify their vehicles using the existing ECE 25 requirements, with one exception. Standard 202 now requires that restraints on vehicles equipped with bench seats must be at least 254 mm (10 inches) wide and other seats must have head restraints that are 171 mm (6.75 inches) wide while ECE 25 specify a 170 mm (6.70 inch) minimum width for all head restraints. The agency has tentatively concluded that the continued use of bench and split bench seats in vehicles manufactured for the U.S. market makes it necessary maintain this portion of FMVSS 202.

The agency is not simply proposing that compliance with ECE 25 be considered to be the equivalent of compliance with the existing version of Standard 202 but is also proposing an upgrade to Standard 202. The proposed upgrade to Standard 202 requires the agency to make a second functional equivalence assessment comparing ECE 25 to the new Standard 202. As outlined above, the agency's functional equivalence assessment in this case has, due to the lack of European crash and compliance test data, focused on existing research regarding the performance of head restraints in reducing whiplash injuries.

The backset, vertical adjustment retention, and existing bench seat head restraint width requirements proposed for the upgrade to Standard 202 do not have counterparts in the European regulations. In performing its functional equivalence assessment, NHTSA found that current research indicates that these requirements are important factors in the safety performance of head restraints. If those new requirements were adopted, ECE 25 could no longer be said to be equivalent to the upgraded Standard. Accordingly, we are not proposing to allow compliance with

ECE 25 as an option after the upgraded requirements go into effect.

VI. Benefits

In support of this rulemaking action, the agency has prepared a Preliminary Economic Assessment (PEA) which contains a thorough analysis of both the benefits and the costs of the changes this document proposes for Standard 202. The analysis contained in the PEA estimates that full implementation of the proposed changes would result in, on an annual basis, 9,575 fewer whiplash injuries for front seat occupants and 4,672 fewer whiplash injuries for rear seat occupants, providing a total of 14,247 fewer whiplash injuries for both front and rear seating positions in rear impacts.

NHTSA estimates from National Automotive Sampling System (NASS) data that, between 1988 and 1996, there were 805,581 occupants with whiplash injuries (non-contact AIS 1 neck injuries) annually in the outboard seating positions of passenger cars (PCs), light trucks, and vans (LTVs) in police reported and unreported towaway and non-towaway nonrollover impacts. However, since the agency believes head restraints will have their greatest effectiveness in rear impacts, the benefits analysis will be restricted to that crash mode only. Based on this same 1988 to 1996 NASS data, the average number of whiplash injuries in rear impacts annually was 272,088. The number of vehicles with head restraints in the rear outboard seats has increased dramatically over the last several years. An estimated 41 percent of the MY 1999 fleet have rear seat head restraints and 20 percent have no rear seat. Because of the increase in the numbers of rear seat head restraints, it is estimated that for the 1999 model year the total population of whiplash injures will be 270,815 (251,035 front seat occupant injuries and 19,780 rear seat occupant injuries).

The average economic cost (excluding property damage) of a whiplash injury in a rear impact, in 1998 dollars, is estimated to be $6,485, resulting in a total annual cost of approximately $1.75 billion for 272,088 whiplash injuries. The $6,485 estimate is based on the assumption that the maximum injury per occupant is an AIS 1 injury. The agency believes that this is a reasonable assumption because very few occupants in the rear impact crashes used to develop our estimate had injuries higher than AIS 1. Further, in such impacts, a whiplash injury is likely to be the most costly AIS 1 injury and the longest lasting one.

The characteristics of adjustable head restraints and their use have changed as well. A 1982 survey of adjustable head restraints indicated that at the lowest position in the range of adjustment, the lowest head restraint was 635 mm (25 inches) high. In a survey conducted for this rulemaking, the agency determined that, at the lowest position of adjustment, the lowest head restraint observed had a height of 712 mm (28 inches). Therefore, the lowest adjustment height for these restraints has increased by three inches. Examination of survey data for the highest position of adjustment indicates that adjustable head restraints are also 40 mm (1.6 inches) higher now at the uppermost range of adjustment than they were in 1982. At the lowest observed position, contemporary adjustable restraints are now 13 mm (.5 inches) lower than integral restraints observed in 1982.

Adjustable restraints are not only higher now than they were in 1982, but they are also more likely to be properly adjusted. While the majority of adjustable head restraints are still not properly adjusted, agency data indicates that 47 percent of current head restraints are properly positioned as opposed to 27 percent in 1982.

The agency believes that about 30 percent of all occupants involved in towaway rear impacts receive a whiplash injury. However, injury rates do not appear to vary significantly between integral and adjustable head restraints. The changes in head restraint configurations and use discussed above may explain why. The data available for front and rear head restraints combined are not sufficient to make statistically valid comparisons between restraint and vehicle types. This data indicated that the average whiplash injury rate for passenger cars with integral head restraints (31.75 per hundred occupants in towaway rear impacts) was higher than the whiplash injury rate (27.99 per hundred) for adjustable head restraints. For LTVs, the data indicated that the average whiplash rate (30.57 per hundred) for adjustable head restraints was slightly higher than the whiplash injury rate (30.53 per hundred) for integral head restraints. Comparing integral restraints by vehicle type shows that the injury rate for cars (31.75 per hundred) exceeds that for trucks (30.53 per hundred) while for adjustable head restraints, the rate for cars is lower (27.99 per hundred) than it is for trucks (30.57 per hundred).

Two sets of data were statistically significant for front occupants only and indicate that integral restraints are performing differently in cars and trucks and in trucks depending on occupant height. For shorter occupants of front outboard seats, the injury rate for trucks with integral restraints was much lower (17.14 per hundred) than the rate for cars (37.94 per hundred). When comparing short drivers with taller drivers in trucks with integral restraints, the taller drivers were injured at a much greater rate (56.71 per hundred) than the shorter (17.14 per hundred). This may indicate that integral head restraints in trucks are better positioned to perform well in preventing injury to short drivers and not as well in protecting tall drivers. Estimates of annual whiplash injury rates by vehicle and restraint type are shown in Table 6.

TABLE 6.—WHIPLASH RATES FOR NONROLLOVER REAR IMPACTS 1988–1996 NASS ANNUALIZED DATA IN TOWAWAY CRASHES

Front and Back Outboard Occupants			
Vehicle Type:		Integral	Adjustable
Car		31.75	27.99
Truck		30.53	30.57
Head Restraint Type:		Car:	Truck:
Integral		31.75	30.53
Adjustable		27.99	30.57
Front Outboard Only			
Vehicle Type:	Occupant Height:	Integral	Adjustable
Car	Short	37.94	31.00

TABLE 6.—WHIPLASH RATES FOR NONROLLOVER REAR IMPACTS 1988–1996 NASS ANNUALIZED DATA IN TOWAWAY CRASHES—Continued

Car	Tall	35.72	28.04
Vehicle Type:	Head Restraint Type:	Short	Tall
Car	Integral	37.94	35.72
Car	Adjustable	31.00	28.04
Vehicle Type:	Occupant Height:	Integral	Adjustable
Truck	Short	17.14	20.65
Truck	Tall	56.71	30.19
Vehicle Type:	Head Restraint Type:	Short:	Tall:
Truck	Integral	17.14	*56.71
Truck	Adjustable	20.65	30.19
Head Restraint Type:	Occupant Height:	Car	Truck
Integral	Short	37.94	*17.14
Integral	Tall	35.72	56.71
Adjustable	Short	31.00	20.65
Adjustable	Tall	28.04	30.19

*Difference is significant at 0.05.

NHTSA estimates that the present fleet of vehicles has an average front seat outboard head restraint maximum height of 768 mm (30.2 inches), which is 32 mm (1.3 inches) less than the proposed minimum height capability of 800 mm (31.5 inches). As outlined in the PEA, the agency believes that raising the height of the front seat outboard head restraint from the present average to 800 mm (31.5 inches) will result in a 1.1 percentage point increase in effectiveness for all rear impact injuries and a 1.83 percentage point increase for whiplash injuries alone.

In examining the effectiveness of the proposed changes, the agency considered the differences between integral and adjustable head restraints. For integral head restraints and those adjustable head restraints properly adjusted in the fully up position (which the agency estimates would be 53 percent of such restraints), the average increase in effectiveness would be a 1.68 percentage points. For the remaining percentage of adjustable head restraints, the 47 percent that would be adjusted in the lowest adjustment position, we estimated that the proposed minimum height of 750 mm (29.5 inches) would result in a 3.50 percentage point increase in effectiveness for all rear impact injuries and 5.83 percentage point increase in effectiveness for whiplash injuries.

Calculating the benefits of the proposed requirements for rear seat head restraints poses several challenges. The baseline heights of rear seats are different than those of front seats. In addition, rear seats are less frequently occupied. When they are occupied, the occupant is often a child. The present fleet also includes vehicles with and without rear seat head restraints.

Agency survey data indicate that, in vehicles with rear seat head restraints, the average lowest head restraint height is 653 mm (25.7 inches), which is 97 mm (3.8 inches) lower than the proposed minimum height of 750 mm (29.5 inches). In models with rear seat adjustable head restraints, the average head restraint height is 655 mm (25.8 inches) and the average seatback height in vehicles without rear seat head restraints is 650 mm (25.6 inches). As outlined in the PEA, an increase in head restraint height from 25.7 inches to the 29.5 inches for front seats would increase effectiveness by 12.35 percentage points. After correcting for the different occupancy rates and occupant heights in rear seats, the average effectiveness for the rear seat would be 13 percent.

Taking into account the differing degrees of effectiveness for each type of head restraint available for front seat occupants, *i.e.,* integral, adjustable in the highest position, and adjustable in the lowest position, the agency estimates that the increase in minimum head restraint height for integral head restraints would result in 1,588 fewer injuries per year. For adjustable head restraints adjusted to the highest position, it is anticipated that the proposed increase in minimum height would result in 1,959 fewer front seat occupant injuries per year. Reductions in injuries for adjustable head restraints in the lowest position would be 6,028 front seat occupant injuries annually. The total reduction in injuries attributable to the proposed front seat head restraint requirements would be 9,575 fewer injuries per year.

For the rear seat, the proposed head restraint requirement, which would require head restraints to be installed at locations where they were not previously required, would result in 4,642 fewer injuries per year.

Adding the benefits from the rear seat requirements to those calculated for the front seat results in rear impact crashes alone a total reduction of 14,247 whiplash injuries each year.

The agency has not prepared an analysis of the potential benefits of two other new requirements contained in this proposal—the backset requirement and the adjustment lock requirement. It should be noted that while there is a general consensus among safety researchers that a smaller backset will result in a reduction of injuries, NHTSA has not yet developed a methodology for quantitatively assessing this benefit. Similarly, the benefits of adding a height locking requirement have also not been calculated. The agency has not determined how many vehicles in the current fleet have height locks for their head restraints. Therefore, a baseline for calculating benefits has not been developed. Further, the benefits of such locks will depend entirely on the rate at which they are employed. As NHTSA does not have access to such data at this time, no estimation of the benefits of the height lock requirement has been prepared.

VII. Costs

In estimating the costs of the proposed requirements, the agency relied on a 1992 NHTSA tear down study of a variety of vehicles. As outlined in the PEA, this study, adjusted to 1998 dollar values, revealed that the sales weighted average cost of integral head restraints is $30.12 per restraint. The same analysis applied to adjustable head restraints indicated an average cost of $29.13 per restraint. The average cost for both adjustable and integral is $29.44 per restraint. As the proposal contains provisions requiring that head restraints be higher than the existing ones in the front and rear seats, we used data from the 1992 study also to calculate the cost per inch of head restraint. Using the same tear-down study and distinguishing between integral and adjustable head restraints, the agency calculated a cost per inch of $1.40 for integral head restraints and $1.46 per inch for adjustable head restraints. As these calculations indicated little difference in cost between integral and adjustable head restraints, the agency estimated that the sales weighted average cost per inch of head restraints for all restraints, in 1998 dollars, was $1.54. In determining the overall cost of compliance with the proposed regulations both in situations where existing head restraints must be raised or a head restraint must be added to the rear seat, we have tentatively concluded that an average cost of $1.54 per additional inch of head restraint height is appropriate.

To evaluate the cost of the proposed minimum height requirements, NHTSA assumed that the cost increase associated with this new requirement is the cost of increasing the highest head restraint position up to 800 mm (31.5 inches) in the front seat or to 750 mm (29.5 inches) in the rear seat. As we believe that the cost of head restraints would be very similar for adjustable and integral head restraints, we assume that the true cost would be to raise the highest height of the head restraint and that changes in design, at no additional variable cost, could be accomplished to comply with the minimum height requirements.

The agency believes that the backset requirements would not add cost to the vehicle. There would be some redesign costs to both increase the height and reduce the backset, but the agency believes that the backset requirement is a design change that could be implemented at the same time as height is increased, with no increase in head restraint cost.

Light vehicle sales in the U.S. totaled 15.55 million units in 1998. There were 8.14 million car sales and 7.40 million truck sales in the U.S. in 1998. All of these vehicles would be required to have higher front seat head restraints. The cost of raising front seat head restraints would be $4.21 per vehicle, resulting in a fleet cost of $65.5 million. In regard to rear seats without head restraints, raising the seat back to create an integral restraint would cost $12.34 per vehicle, resulting in a fleet cost of $74.8 million. Raising the rear seat head restraints in vehicles already equipped with rear head restraints costs $3.61 per vehicle, resulting in a fleet cost of $19.6 million. There would be a small cost to add locking mechanisms to those head restraints that do not currently have such mechanisms. Our studies indicate that approximately half of the existing fleet with adjustable head restraints has locking mechanisms. Adding locking mechanisms to the rest of the fleet with adjustable head restraints at a cost of $0.15 per vehicle is projected to result in costs of $3.3 million for front seat restraints and $2.6 million for rear seats for a combined total is $5.9 million. The total estimated costs of the vehicle changes that would be required by this proposal would be $160.5 million ($65.5 million for the front seat and $95.0 million for the rear seat).

VIII. Effective Date

As noted above, the agency is proposing two amended versions of Standard 202. The first version would become effective 90 days after issuance of the final rule. It would allow three options for compliance. The first option would be compliance with the requirements of the existing Standard 202. The second option would allow manufacturers to comply with the requirements of ECE 25 as supplemented by the current width requirements. The third option would allow manufacturers to comply with the new upgraded Standard 202 requirements, which would apply to vehicles manufactured on or after the first occurrence of September 1, three years after the publication of the final rule, before that date. Between the effective date of the final rule and August 31, 2004, manufacturers may choose one of the foregoing three options when certifying their vehicles. However, the election of the option used by the manufacturer in certifying the vehicle, including the choice between the static and dynamic test options, must be made at or before the time of certification, and the manufacturer may not thereafter rely on any other test option to establish compliance.

The agency is proposing that compliance with the upgraded version of the standard become mandatory on the first occurrence of September 1, three years after publication of the final rule. NHTSA believes that this date will provide manufacturers with sufficient leadtime to redesign seats and seating systems in production vehicles and to incorporate new elements of head restraint design in new models.

IX. Rulemaking Analyses and Notices

A. Executive Order 12866 and DOT Regulatory Policies and Procedures

NHTSA has considered the impact of this rulemaking action under Executive Order 12866 and the Department of Transportation's regulatory policies and procedures. This rulemaking document was reviewed by the Office of Management and Budget under Executive Order 12866, ''Regulatory Planning and Review.'' The rulemaking action has been determined to be economically significant. NHTSA is placing in the public docket a Preliminary Economic Assessment (PEA) describing the costs and benefits of this rulemaking action. The costs and benefits are summarized earlier in this document.

B. Regulatory Flexibility Act

NHTSA has considered the effects of this rulemaking action under the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) I hereby certify that the proposed amendment would not have a significant economic impact on a substantial number of small entities.

The proposed rule would affect motor vehicle manufacturers, alterers, and seating manufacturers.

NHTSA estimates that there are only about four small passenger car and light truck manufacturers in the United States. These manufacturers serve a niche market. The agency believes that small manufacturers manufacture less than 0.1 percent of total U.S. passenger car and light truck production per year.

There are about 30 seating manufacturers in the U.S. Many of these are small businesses. The proposed rule would affect these small businesses by changing the requirements for head restraints. Raising the height of and integral seat or of an adjustable head restraint is not a new or novel idea. The agency does not believe that this will have a significant impact on these manufacturers.

NHTSA notes that final stage vehicle manufacturers and alterers could also be affected by this proposal. Many final stage manufacturers and alterers install supplier constructed seating systems in vehicles they produce. The proposal would not have any significant effect on final stage manufacturers or alterers, however, since the seats they purchase should be tested and certified by the seat manufacturer.

Small organizations and small governmental units would not be significantly affected since the potential cost impacts associated with this proposed action should only slightly affect the price of new motor vehicles.

For the reasons discussed above, the small entities that would most likely be affected by this proposal are small vehicle manufacturers, seating manufacturers, final stage manufacturers and alterers.

The agency believes, further, that the economic impact on these manufacturers would be small. While the small vehicle manufacturers would face additional compliance costs, the agency believes that seating manufacturers would likely provide much of the engineering expertise necessary to meet the new requirements. Raising the height of a head restraint is not a new or novel engineering task. However, doing so for many makes and models at the same time could present a challenge. The agency also notes that, in the unlikely event that a small vehicle manufacturer or alterer did face substantial economic hardship, it could apply for a temporary exemption for up to three years. See 49 CFR Part 555. It could subsequently apply for a renewal of such an exemption. However, the agency requests comments concerning:

32. The economic impact of the proposed rule on small vehicle manufacturers, seating manufacturers, final stage manufacturers and vehicle alterers.

Additional information concerning the potential impacts of the proposed requirements on small entities is presented in the PEA.

C. National Environmental Policy Act

NHTSA has analyzed this proposal for the purposes of the National Environmental Policy Act. The agency has determined that implementation of this action would not have any significant impact on the quality of the human environment.

D. Executive Order 13132 (Federalism)

The agency has analyzed this rulemaking in accordance with the principles and criteria contained in Executive Order 13132 and has determined that it does not have sufficient federalism implications to warrant consultation with State and local officials or the preparation of a federalism summary impact statement. The final rule has no substantial effects on the States, or on the current Federal-State relationship, or on the current distribution of power and responsibilities among the various local officials.

E. Unfunded Mandates Act

The Unfunded Mandates Reform Act of 1995 requires agencies to prepare a written assessment of the costs, benefits and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local or tribal governments, in the aggregate, or by the private sector, of more than $100 million annually (adjusted for inflation with base year of 1995). This assessment is included in the PEA.

F. Civil Justice Reform

This proposal would not have any retroactive effect. Under 49 U.S.C. 21403, whenever a Federal motor vehicle safety standard is in effect, a State may not adopt or maintain a safety standard applicable to the same aspect of performance which is not identical to the Federal standard, except to the extent that the state requirement imposes a higher level of performance and applies only to vehicles procured for the State's use. 49 U.S.C. 21461 sets forth a procedure for judicial review of final rules establishing, amending or revoking Federal motor vehicle safety standards. That section does not require submission of a petition for reconsideration or other administrative proceedings before parties may file suit in court.

G. National Technology Transfer and Advancement Act

Under the National Technology Transfer and Advancement Act of 1995 (NTTAA)(Public Law 104–113), ''all Federal agencies and departments shall use technical standards that are developed or adopted by voluntary consensus standards bodies, using such technical standards as a means to carry out policy objectives or activities determined by the agencies and departments.'' This action proposes to modify performance requirements for head restraints to allow, on an interim basis, compliance with either U.S. or ECE requirements. After the end of the interim period, head restraints must comply with the proposed U.S. requirements. Certain technical standards developed by the Society of Automotive Engineers (SAE) and other bodies have been incorporated into this proposal but the overall need for safety precludes, in NHTSA's view, the adoption of such voluntary standards as a substitute for this proposal.

H. Paperwork Reduction Act

This rule does not contain any collection of information requirements requiring review under the Paperwork Reduction Act of 1995 (Public Law 104–13).

X. Submission of Comments

How Can I Influence NHTSA's Thinking on This Proposed Rule?

In developing this proposal, we tried to address the concerns of all our stakeholders. Your comments will help us improve this rule. We invite you to provide different views on options we propose, new approaches we haven't considered, new data, how this proposed rule may affect you, or other relevant information. We welcome your views on all aspects of this proposed rule, but request comments on specific issues throughout this notice. We grouped these specific requests near the end of the sections in which we discuss the relevant issues. Your comments will be most effective if you follow the suggestions below:

- Explain your views and reasoning as clearly as possible.
- Provide solid technical and cost data to support your views.
- If you estimate potential costs, explain how you arrived at the estimate.
- Tell us which parts of the proposal you support, as well as those with which you disagree.
- Provide specific examples to illustrate your concerns.
- Offer specific alternatives.
- Refer your comments to specific sections of the proposal, such as the units or page numbers of the preamble, or the regulatory sections.
- Be sure to include the name, date, and docket number with your comments.

How Do I Prepare and Submit Comments?

Your comments must be written and in English. To ensure that your comments are correctly filed in the Docket, please include the docket number of this document in your comments.

Your comments must not be more than 15 pages long. (49 CFR 553.21). We established this limit to encourage you to write your primary comments in a concise fashion. However, you may attach necessary additional documents to your comments. There is no limit on the length of the attachments.

Please submit two copies of your comments, including the attachments, to Docket Management at the address given above under **ADDRESSES**.

Comments may also be submitted to the docket electronically by logging onto the Dockets Management System website at http://dms.dot.gov. Click on ''Help & Information'' or ''Help/Info'' to obtain instructions for filing the document electronically.

How Can I Be Sure That My Comments Were Received?

If you wish Docket Management to notify you upon its receipt of your comments, enclose a self-addressed, stamped postcard in the envelope containing your comments. Upon receiving your comments, Docket Management will return the postcard by mail.

How Do I Submit Confidential Business Information?

If you wish to submit any information under a claim of confidentiality, you should submit three copies of your complete submission, including the information you claim to be confidential business information, to the Chief Counsel, NHTSA, at the address given above under **FOR FURTHER INFORMATION CONTACT**. In addition, you should submit two copies, from which you have deleted the claimed confidential business information, to Docket Management at the address given above under **ADDRESSES**. When you send a comment containing information claimed to be confidential business information, you should include a cover letter setting forth the information specified in our confidential business information regulation. (49 CFR Part 512.)

Will the Agency Consider Late Comments?

We will consider all comments that Docket Management receives before the close of business on the comment closing date indicated above under **DATES**. To the extent possible, we will also consider comments that Docket Management receives after that date. If Docket Management receives a comment too late for us to consider it in developing a final rule (assuming that one is issued), we will consider that comment as an informal suggestion for future rulemaking action.

How Can I Read the Comments Submitted by Other People?

You may read the comments received by Docket Management at the address given above under **ADDRESSES**. The hours of the Docket are indicated above in the same location.

You may also see the comments on the Internet. To read the comments on the Internet, take the following steps:

(1) Go to the Docket Management System (DMS) Web page of the Department of Transportation (*http://dms.dot.gov/*).

(2) On that page, click on ''search.''

(3) On the next page (http://dms.dot.gov/search/), type in the four-digit docket number shown at the beginning of this document. Example: If the docket number were ''NHTSA–1998–1234,'' you would type ''1234.'' After typing the docket number, click on ''search.''

(4) On the next page, which contains docket summary information for the docket you selected, click on the desired comments. You may download the comments. However, since the comments are imaged documents, instead of word processing documents, the downloaded comments are not word searchable.

Please note that even after the comment closing date, we will continue to file relevant information in the Docket as it becomes available. Further, some people may submit late comments. Accordingly, we recommend that you periodically check the Docket for new material.

Plain Language

Executive Order 12866 and the President's memorandum of June 1, 1998, require each agency to write all rules in plain language. Application of the principles of plain language includes consideration of the following questions:

- Have we organized the material to suit the public's needs?
- Are the requirements in the rule clearly stated?
- Does the rule contain technical language or jargon that isn't clear?
- Would a different format (grouping and order of sections, use of headings, paragraphing) make the rule easier to understand?
- Would more (but shorter) sections be better?
- Could we improve clarity by adding tables, lists, or diagrams?
- What else could we do to make the rule easier to understand?

If you have any responses to these questions, please include them in your comments on this proposal.

List of Subjects in 49 CFR Part 571

Imports, Motor vehicle safety, Motor vehicles.

In consideration of the foregoing, it is proposed that 49 CFR part 571 be amended as follows:

PART 571—FEDERAL MOTOR VEHICLE SAFETY STANDARDS

1. The authority citation for part 571 of title 49 would be revised to read as follows:

Authority: 49 U.S.C. 322, 30111, 30115, 30117, and 30166; delegation of authority at 49 CFR 1.50.

2. Section 571.202 would be revised to read as follows:

§ 571.202 Standard No. 202; Head restraints.

S1. *Purpose and scope.* This standard specifies requirements for head restraints to reduce the frequency and severity of neck injury in rear-end and other collisions.

S2. *Application.* This standard applies to passenger cars, and to multipurpose passenger vehicles, trucks and buses with a GVWR of 4,536 kg (10,000 pounds) or less manufactured before [Insert a date which is the first occurrence of September 1, three years after publication of the final rule].

S3. *Definitions.*

Head restraint means a device that limits rearward displacement of a seated occupant's head relative to the occupant's torso.

S4. *Requirements.*

S4.1 Each passenger car must comply with, at the manufacturer's option, either S4.3, S4.4 or S4.5 of this section.

S4.2 Each truck, multipurpose passenger vehicle and bus with a GVWR of 4,536 kg (10,000 pounds) or less must comply with, at the manufacturer's option, either S4.3, S4.4 or S4.5 of this section.

S4.3 Except for school buses, a head restraint that conforms to either S4.3 (a) or (b) of this section must be provided at each outboard front designated seating position. For school buses, a head restraint that conforms to either S4.3 (a) or (b) of this section must be provided for the driver's seating position.

(a) It must, when tested in accordance with S5.1 of this section, limit rearward angular displacement of the head reference line to 45 degrees from the torso reference line; or

(b) It must, when adjusted to its fully extended design position, conform to each of the following—

(1) When measured parallel to torso line, the top of the head restraint must not be less than 700 mm above the seating reference point;

(2) When measured either 64 mm below the top of the head restraint or 635 mm above the seating reference point, the lateral width of the head restraint must be not less than—

(i) 254 mm for use with bench-type seats; and

(ii) 171 mm for use with individual seats;

(3) When tested in accordance with S5.2 of this section, any portion of the head form in contact with the head restraint must not be displaced to more than 102 mm perpendicularly rearward of the displaced extended torso reference line during the application of the load specified in S5.2(c) of this section; and

(4) When tested in accordance with S5.2 of this section, the head restraint must withstand an increasing load until one of the following occurs:

(i) Failure of the seat or seat back; or,

(ii) Application of a load of 890N.

S4.4 Except for school buses, a head restraint that conforms to S4.4 (a) and (b) of this section must be provided at each outboard front designated seating position. For school buses, a head restraint that conforms to S4.4 (a) and (b) of this section must be provided for the driver's seating position.

(a) The head restraint must comply with paragraphs 6.1 through 6.6.3, 6.8 through 6.10, 7, and 8 of the following English language version of the Economic Commission for Europe Regulation 25: E/ECE/324–E/ECE/TRANS/505/Rev.1/Add.24/Rev.1, as amended by E/ECE/324–E/ECE/TRANS/505/Rev.1/Add.24/Rev.1/Corr.1, E/ECE/324–E/ECE/TRANS/505/Rev.1/Add.24/Rev.1/Amend.1, and E/ECE/324–E/ECE/TRANS/505/Rev.1/Add.24/Rev.1/Amend.2. (A copy of paragraphs 2, 6.1 through 6.6.3 and 6.8 through 6.10, 7, and 8 may be reviewed at the DOT Docket Management Facility, U.S. Department of Transportation, Room PL–01, 400 Seventh Street, SW., Washington, DC 20590–0001. Copies of E/ECE/324–E/ECE/TRANS/505, Rev.1/Add.24/Rev.1/Amend.2, 16 April 1997 may be obtained from the ECE Internet site at http://www.unece.org/trans/main/wp29/wp29regs.html or by writing to the United Nations, Conference Services Division, Distribution and Sales Section, Office C.115–1, Palais des Nations, CH–1211, Geneva 10, Switzerland); and

(b) The head restraint must meet the width requirements specified in S4.3(b)(2) of this section.

S4.5 Head restraints that comply with the requirements of § 571.202a of this part, becoming effective on [Insert a date which is the first occurrence of September 1, three years after publication of the final rule], must be provided at each outboard designated seating position.

S4.6 Whenever this standard provides an option for compliance the manufacturer must select the option no later than the time it certifies the vehicle and may not thereafter select a different option for the vehicle.

S5. *Demonstration procedures.*

S5.1 Compliance with S4.3(a) of this section is demonstrated in accordance with the following with the head restraint in its fully extended design position:

(a) On the exterior profile of the head and torso of a dummy having the weight and seated height of a 95th percentile adult male with an approved representation of a human, articulated neck structure, or an approved equivalent test device, establish reference lines by the following method:

(1) Position the dummy's back on a horizontal flat surface with the lumbar joints in a straight line.

(2) Rotate the head of the dummy rearward until the back of the head contacts the same flat horizontal surface in paragraph (a)(1) of S5.1 of this section.

(3) Position the SAE J–826 two-dimensional manikin's back against the flat surface in S5.1(a)(1) of this section, alongside the dummy with the h-point of the manikin aligned with the h-point of the dummy.

(4) Establish the torso line of the manikin as defined in SAE Aerospace-Automotive Drawing Standards, sec. 2.3.6, P.E1.01, September 1963.

(5) Establish the dummy torso reference line by superimposing the torso line of the manikin on the torso of the dummy.

(6) Establish the head reference line by extending the dummy torso reference line onto the head.

(b) At each designated seating position having a head restraint, place the dummy, snugly restrained by a Type 2 seat belt, in the manufacturer's recommended design seated position.

(c) During forward acceleration applied to the structure supporting the seat as described in this paragraph, measure the maximum rearward angular displacement between the dummy torso reference line and head reference line. When graphically depicted, the magnitude of the acceleration curve must not be less than that of a half-sine wave having the amplitude of 78 m/s^2 and a duration of 80 milliseconds and not more than that of a half-sine wave curve having an amplitude of 94 m/s^2 and a duration of 96 milliseconds.

S5.2 Compliance with S4.3(b) of this section is demonstrated in accordance with the following with the head restraint in its fully extended design position:

(a) Place a test device, having the back plan dimensions and torso line (centerline of the head room probe in full back position), of the three dimensional SAE J826 manikin, at the manufacturer's recommended design seated position.

(b) Establish the displaced torso reference line by applying a rearward moment of 373 Nm moment about the seating reference point to the seat back through the test device back pan located in paragraph S5.2(a) of this section.

(c) After removing the back pan, using a 165 mm diameter spherical head form or cylindrical head form having a 165 mm diameter in plan view and a 152 mm height in profile view, apply, perpendicular to the displaced torso reference line, a rearward initial load 64 mm below the top of the head restraint that will produce a 373 Nm moment about the seating reference point.

(d) Gradually increase this initial load to 890 N or until the seat or seat back fails, whichever occurs first.

* * * * *

3. On [Insert a date which is the first occurrence of September 1, three years after publication of the final rule], § 571.202(a) would be added to read as follows:

§ 571.202(a) Standard 202; Head restraints.

S1. *Purpose and scope.* This standard specifies requirements for head restraints to reduce the frequency and severity of neck injury in rear-end and other collisions.

S2. *Application.* This standard applies to passenger cars, and to multipurpose passenger vehicles, trucks and buses with a GVWR of 4526 kg (10,000 pounds) or less.

S3. *Definitions.*

Backset means the minimum horizontal distance between the rear of a representation of the head of a seated 50th percentile male occupant and the head restraint.

Head restraint means a device that limits rearward displacement of a seated occupant's head relative to the occupant's torso.

Height means the distance from the H-point to a point measured parallel to the torso reference line defined by the three dimensional SAE J826 (July 1995) manikin.

Top means the point on the head restraint with the greatest height.

S4. *Requirements.*

S4.1 Except as provided in S4.3 of this section, each vehicle must comply with S4 of this section.

S.4.2 *Performance levels.* In vehicles other than school buses, a head restraint that conforms to either S4.2(a) or (b) of this section must be provided at each outboard designated seating position. In school buses, a head restraint that conforms to either S4.2(a) or (b) of this section must be provided for the driver's seating position.

(a) *Dynamic performance and width.* Each head restraint must conform to the following—

(1) When tested in accordance with S5.1 of this section, during a forward acceleration of the dynamic test platform described in S5.1(a), the head restraint must—

(i) Limit the rearward angular displacement between the dummy's head and torso to 12 degrees for the 50th percentile male dummy in front and rear seating positions and 20 degrees for the 95th percentile male dummy in front seating positions; and

(ii) Limit HIC to 150, when calculated in accordance with the following formula:

$$HIC = \left[\frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} a\,dt \right]^{2.5} (t_2 - t_1)$$

Where the term a is the resultant head acceleration expressed as a multiple of g (the acceleration of gravity), and t1 and t2 are any two points in time during the impact which are separated by not more than a 15 millisecond time interval; and

(2) The head restraint must have the lateral width specified in S4.2(b)(3) of this section.

(b) *Dimensional and static performance.* Each head restraint must conform to each of paragraphs S4.2(b) (1) through (12) of this section:

(1) *Minimum height capability.* When measured in accordance with S5.2(a) of this section, the top of head restraints in front seating positions must be capable of being positioned at a height not less than 800 mm (31.5 inches).

(2) *Minimum height limit.* When measured in accordance with S5.2(b) of this section, the top of the head restraint must have a height not less than 750 mm (29.5 inches) in any position of adjustment.

(3) *Width.* When measured 64 ± 3 mm (2.5 ± 0.1 inches) below the top of the head restraint, the lateral width of the head restraint must be not less than—

(i) 254 mm (10 inches), in the case of head restraints on bench-type seats; and

(ii) 171 mm (6.75 inches), in the case of head restraints on individual seats.

(4) *Backset.* When measured in accordance with S5.2(c) of this section, the head restraint backset must be not more than 50 mm (1.97 inches), with the top of adjustable head restraints in any height position of adjustment between 750 mm (29.5 inches) and 800 mm (31.5 inches).

(5) *Gaps.* Except as provided in S4.2(b)(6) of this section, when measured in accordance with S5.3 of this section using the described head form, there must not be any gap greater than 60 mm (2.36 inches) in the front surface of the head restraint or between the front surface of the head restraint and the front surface of the seat.

(6) *Gaps.* For adjustable head restraints, when measured in accordance with S5.3 of this section using the described head form, there must be no gap greater than 25 mm (1 inch) between the front surface of the head restraint and the front surface of the seat.

(7) *Energy absorption.* When the front surface of the head restraint is impacted in accordance with S5.4 of this section by the described head form at any velocity up to and including 24.1 kilometers per hour (15 mph), the deceleration of the head form must not exceed 785 m/s^2 (80g) continuously for more than 3 milliseconds.

(8) *Radius of curvature.* Any portion of the front surface of the seat or head restraint that has a height greater than 635 mm (25 inches) and that is outside of the impact area described in S5.4(c) of this section must either have a radius of curvature of not less than 5 mm (0.2 inches) or meet the requirement of S4.2(b)(7) of this section when tested outside the impact area.

(9) *Height retention.* When tested in accordance with S5.5 of this section, the lowest portion of the described head form must return to within 10 mm (0.4 inches) of its initial reference position after application of at least a 500 N (112 pound) load and reduction of the load to 50 ± 1 N (11.2 ± 0.2 pounds).

(10) *Displacement.* When tested in accordance with S5.6(a) through (f) of this section, the rearmost portion of the described head form must not be displaced to more than 102 mm (4 inches) perpendicularly rearward of the displaced extended torso reference line during the application of a 373 ± 7.5 Nm (3,300 ± 66 inch-pounds) moment about the H-point.

(11) *Backset retention.* When tested in accordance with S5.6 of this section, the rearmost portion of the described head form must return to within 10 mm (0.39 inches) of its initial reference position after application of a 373 ± 7.5 Nm (3,300 ± 66 inch-pounds) moment about the H-point and reduction of the moment to 37 ± 0.7 Nm (327 ± 6.5 inch-pounds).

(12) *Strength.* When tested in accordance with S5.6 of this section, the head restraint must provide a resistance to the test device of at least 890 N (200 pounds).

S4.3 *Folding or retracting head restraints for unoccupied seats.* A rear seat head restraint may be adjustable by folding or retracting to a position in which its minimum height is less than that specified in S4.2(b)(2) of this section or in which its backset is more than that specified in S4.2(b)(4) of this section. In any such position, the head restraint must meet either S4.3(a) or (b) of this section.

(a) The head restraint must automatically return to a position in which its height is not less than that specified in S4.2(b)(2) of this section and its backset is not more than that specified in S4.2(b)(4) of this section when a test dummy representing a 5th percentile female is positioned in the seat and when a test dummy representing 50th percentile male is positioned in the seat and the midsagittal plane of the test dummy is aligned within 15 mm (0.6 inches) of the head restraint centerline; or

(b) The head restraint must, when tested in accordance with S5.7 of this section, cause the torso reference line angle to be at least 10 degrees closer to vertical than when the head restraint is in any position of adjustment in which its height is not less than that specified in S4.2(b)(2) of this section and its backset is not more than that specified in S4.2(b)(4) of this section.

S4.4 *Removability of head restraints.* A front seat head restraint must not be removable from the seat solely by hand. A rear seat head restraint may be removable from the seat solely by hand.

S4.5 *Compliance option selection.* Whenever this standard provides an option for compliance, the manufacturer must select the option not later than the time it certifies the vehicle and may not thereafter select a different option for the vehicle.

S5. *Procedures.* Demonstrate compliance with S4.2 and S4.3 of this section with any adjustable lumbar support adjusted to its rearwardmost nominal design position in forward facing seats and its forwardmost nominal design position in rear facing seats. Except for S5.1 of this section, if the seat back is adjustable, it shall be set at an initial inclination position closest to 25 degrees from the vertical, as measured by the three dimensional SAE J826 manikin (July 1995) equipped with the ICBC Head Restraint Measuring Device (available from the Insurance Corporation of British Columbia, 151 West Esplanade, North Vancouver, BC V7M 3H9, Canada. www.icbc.com). The order of test performance is S5.7 and S5.1 to S5.6 of this section, in numerical order.

S5.1 *Procedures for dynamic performance.* Demonstrate compliance with S4.2(a) of this section in accordance with S5.1(a) though (i) of this section with the head restraints in any backset position of adjustment. For all seating positions demonstrate compliance with a 50th percentile male Hybrid III test dummy specified in 49 CFR part 572, subpart E. For front seating positions demonstrate compliance with a 95th percentile male Hybrid III test dummy specified in 49 CFR part 572. When testing with the 95th percentile dummy demonstrate compliance with the head restraint at one height position of adjustment, at the option of the manufacturer. When testing with the 50th percentile demonstrate compliance with the head restraint at any height position of adjustment.

(a) Mount the vehicle on a dynamic test platform at the vehicle attitude set forth in S13.3 of § 571.208 of this part, so that the longitudinal centerline of the vehicle is parallel to the direction of the test platform travel and so that movement between the base of the vehicle and the test platform is prevented. Instrument the platform with an accelerometer and data processing system having a frequency response of channel class 60 as specified in the Society of Automotive Engineers (SAE) Recommended Practice J211/1, March 1995. Position the accelerometer sensitive axis parallel to the direction of test platform travel.

(b) Remove the tires, wheels, battery, fluids, and all unsecured components. Remove or rigidly secure the engine, transmission, axles, exhaust, vehicle frame, etc. in order to assure that all points on the acceleration vs. time plot measured by an accelerometer on the floor pan fall within the corridor described in Figure 1 and Table 1.

(c) Place any moveable windows in the fully open position.

(d) At each outboard designated seating position, place the test dummy with the seat adjusted as specified in S8.1.2 through S8.1.3 of § 571.208 of this part. Prior to placing the Type 2 seat belt around the test dummy, exercise the seat belt retractor(s) three times to remove slack.

(e) Dress and adjust each test dummy as specified in S8.1.8.2 through S8.1.8.3 of § 571.208 of this part.

(f) Position each test dummy as specified in S10.1 through S10.3 of § 571.208 of this part and S7.1 through S7.4 of § 571.214 of this part, except for the following:

(1) If it is not possible to position the test dummy so that the midsagittal plane is aligned within 15 mm (0.6 inches) of the head restraint centerline, follow the positioning procedure in S7.1 through S7.4 of § 571.214 of this part.

(2) The H-point of the 95th percentile male test dummy coincides within 13 mm (0.5 inches) in the vertical dimension and 13 mm (0.5 inches) in the horizontal dimension of a point 9 mm (0.4 inches) above and 15 mm (0.6 inches) forward of the H-point of the seat.

(g) Accelerate the dynamic test platform such that it experiences a forward velocity change of 17.3 ± 0.6 kph (10.8 ± 0.37 mph) and all of the points on the acceleration vs. time curve fall within the corridor described in Figure 1 and Table 1. Measure the maximum rearward angular displacement between the head and torso of each dummy.

(h) Calculate the angular displacement from the output of instrumentation placed in the torso and head of the test dummy and an algorithm capable of determining the relative angular displacement to within one degree and conforming to the requirements for a 600 Hz channel class as specified in SAE Recommended Practice J211/1 (March 1995). No data generated after 200 ms from the beginning of the forward acceleration are used in determining angular displacement.

(i) Calculate the HIC from the output of instrumentation placed in the head of the test dummy using the equation in S4.2(a)(1)(ii) of this section and conforming to the requirements for a 1000 Hz channel class as specified in SAE Recommended Practice J211/1 (March 1995). No data generated after 200 ms from the beginning of the forward acceleration are used in determining angular displacement.

S5.2 *Procedures for height and backset.* Demonstrate compliance with S4.2(b)(1), (2), and (4) of this section in accordance with S5.2(a) through (c) of this section.

(a) For adjustable head restraints in front seating positions, adjust the top of the head restraint to its highest position and measure the height. For all other head restraints in front seating positions, measure the height.

(b) For adjustable head restraints, adjust the top of the head restraint to its lowest position and measure the height. For all other head restraints, measure the height.

(c) For adjustable head restraints, adjust the head restraint so that its top is at any height between 750 mm (29.5 inches) and 800 mm (31.5 inches) and to the maximum backset position at that height, and measure the backset. For all other head restraints, measure the backset.

S5.3 *Procedures for measuring gaps.* Demonstrate compliance with S4.2(b)(5) and (6) of this section in accordance with the requirements of S5.3(a) through (c) of this section. For adjustable head restraints, demonstrate compliance with the head restraint adjusted to its minimum height position. Demonstrate compliance with S4.2(b)(5) of this section at any backset position of adjustment. Demonstrate compliance with S4.2(b)(6) of this section at one backset position of adjustment, at the option of the manufacturer.

(a) The area of measurement is anywhere on the front surface of the head restraint or seat with a height greater than 540 mm (21.3 inches) and within a distance of the head restraint vertical centerline of—

(1) 127 mm (5 inches) for bench-type seats; and

(2) 85 mm (3.4 inches) for individual seats.

(b) Place a 165 ± 2 mm (6.5 ± 0.1 inches) diameter spherical head form against any gap such that only two points of contact are made. The surface roughness of the head form is less than 1.6 µm, root mean square.

(c) Determine the gap dimension by measuring the straight line distance between the two contact points, as shown in Figures 2 and 3.

S5.4 *Procedures for energy absorption.* Demonstrate compliance with S4.2(b)(7) of this section in accordance with S5.4(a) through (e) of this section, with the seatback rigidly fixed and adjustable head restraints in any height and backset position of adjustment.

(a) Propel a semispherical head form with a 165 ± 2 mm (6.5 ± 0.1 inches) diameter and a surface roughness of less than 1.6 µm, root mean square, into the head restraint. The head form and associated base have a combined mass of 6.8 ± 0.05 kg (15 ± 0.1 pound).

(b) Instrument the head form with an acceleration sensing device whose output is recorded in a data channel that conforms to the requirements for a 600 Hz channel class as specified in SAE Recommended Practice J211/1 (March 1995). The axis of the acceleration sensing device coincides with the geometric center of the head form and the direction of impact.

(c) At the time of launch, the longitudinal axis of the head form is within 2 degrees of being horizontal and parallel to the vehicle longitudinal axis. The direction of travel is rearward.

(d) The headform travels freely through the air along the path described in S5.4(b) of this section not less than 25 mm (1 inch) before making contact with the head restraint.

(e) Impact the front surface of the seat or head restraint at any point with a height greater than 635 mm (25 inches) and within a distance of the head restraint vertical centerline of—

(1) 105 mm (4.1 inches) for bench-type seats; and

(2) 70 mm (2.8 inches) for individual seats.

S5.5 *Procedures for height retention.* Demonstrate compliance with S4.2(b)(9) of this section in accordance with S5.5 (a) through (d) of this section.

(a) Adjust adjustable head restraints so that the top of the head restraint is at any of the following height positions at any backset position—

(1) For front seating positions—

(i) The highest position;

(ii) Not less than, but closest to 800 mm (31.5 inches);

(iii) Not less than, but closest to 750 mm (29.5 inches); and

(2) For rear seating positions—

(i) The highest position; and

(ii) Not less than, but closest to 750 mm (29.5 inches).

(b) Establish the head form initial reference position by applying a vertical downward load of 50 N ± 1 (11.2 ± 0.2 pounds) to the top of the head restraint at the head restraint centerline using a 165 ± 2 mm (6.5 ± 0.1 inch) diameter spherical head form with a surface roughness of less than 1.6 μm, root mean square.

(c) Increase the load at the rate of 250 ± 50 N/minute (50.6 ± 10 pounds/minute) to at least 500 N (112 pounds) and maintain this load level for not less than 5 seconds.

(d) Reduce the load at the rate of 250 ± 50 N/minute (50.6 ± 11.2 pounds/minute) to 50 ± 1 N (11.2 ± 0.22 pounds) and determine the head form position with respect to its initial reference position.

S5.6 *Procedures for displacement, backset retention and strength.* Demonstrate compliance with S4.2(b)(10) through (12) of this section in accordance with S5.6(a) through (h) of this section. The angular orientation of the load vectors generating the specified moments on the head restraint are initially within 2 degrees of a vertical plane parallel to the vehicle longitudinal centerline and do not deviate more than 2 degrees from their initial orientation.

(a) Adjust adjustable head restraints so that the top of the head restraint is at the height not less than, but closest to—

(1) 800 mm (31.5 inches) for front seating positions; and

(2) 750 mm (29.5 inches) for rear seating positions;

(b) Adjust adjustable head restraints to any backset position;

(c) Place a test device, having the back pan dimensions and torso line (vertical centerline), when viewed laterally, of the head room probe in full back position, of the three dimensional SAE J826 manikin, in the seat;

(d) Establish the displaced torso reference line by creating a rearward moment of 373 ± 7.5 Nm (3,300 ± 66 inch-pounds) about the H-point by applying a force to the seat back through the test device back pan located as specified in S5.6(c) of this section at the rate of 187 ± 37 Nm/minute (1,655 ± 327 inch-pounds/minute). The initial location on the back pan of the moment generating force vector has a height of 290 mm ± 13 mm (11.4 ± 0.5 inches). Apply the force vector normal to the torso line and maintain it within 2 degrees of a vertical plane parallel to the vehicle longitudinal centerline. Constrain the back pan to rotate about the H-point. Rotate the force vector direction with the back pan;

(e) Maintain the position of the test device back pan as established in S5.6(d) of this section. Using a 165 ± 2 mm (6.5 ± 0.1 inch) diameter spherical head form with a surface roughness of less than 1.6 μm, root mean square, establish the head form initial reference position by applying, perpendicular to the displaced torso reference line, a rearward initial load on the head restraint centerline 65 ± 3 mm (2.6 ± 0.1 inches) below the top of the head restraint that will produce a 37 ± 0.7 Nm (327 ± 6.5 inch-pounds) moment about the H-point;

(f) Increase this initial load at the rate of 187 ± 37 Nm/minute (1,655 ± 327 inch-pounds/minute) until a 373 ± 7.5 Nm (3,300 ± 66 inch-pound) moment about the H-point is produced. Maintain the load level producing that moment for not less than 5 seconds and then determine the head form position with respect to the displaced torso reference line;

(g) Reduce the load at the rate of 187 ± 37 Nm/minute (1655 ± 327 inch-pounds/minute) until a 37 ± 0.7 Nm (327 ± 6.5 in-pound) moment about the H-point is produced. While maintaining the load level producing that moment, determine the head form position with respect to its initial reference position; and

(h) Increase the load at the rate of 250 ± 50 N/minute (50.6 ± 10 pounds/minute) to at least 890 N (200 pounds) and maintain this load level for not less than 5 seconds.

S5.7 *Procedures for folding or retracting head restraints for unoccupied rear seats.* Demonstrate compliance with S4.3(b) of this section in accordance with S5.7(a) through (d) of this section:

(a) Place the head restraint into any position meeting the requirements of S4.2 of this section;

(b) Measure the torso reference line angle with the three dimensional SAE J826 manikin;

(c) Fold or retract the head restraint to any position in which its minimum height is less than that specified in S4.2(b)(2) of this section or in which its backset is more than that specified in S4.2(b)(4) of this section; and

(d) Again measure the torso reference line angle.

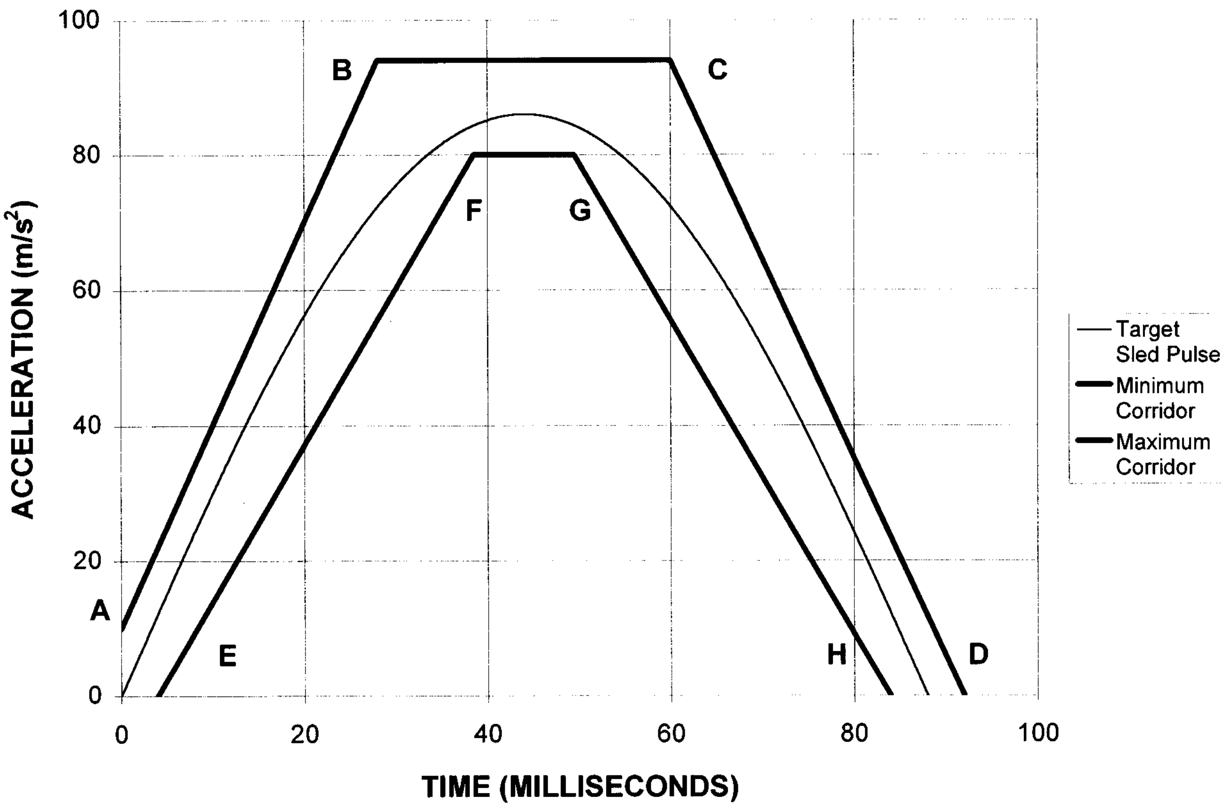

Figure 1 - Sled pulse acceleration corridor. The target acceleration with time expressed in milliseconds is a = 86 Sin(πt/88) m/s^2, for ΔV = 17.3 ± 0.6 kph. The time zero for the test is defined by the point when the sled acceleration achieves 2.5 m/s^2 (0.25 G's).

TABLE 1.—SLED PULSE CORRIDOR REFERENCE POINT LOCATIONS

Reference point	time (ms)	Acceleration (m/s^2)
A	0	10
B	28	94
C	60	94
D	92	0
E	4	0
F	38.5	80
G	49.5	80
H	84	0

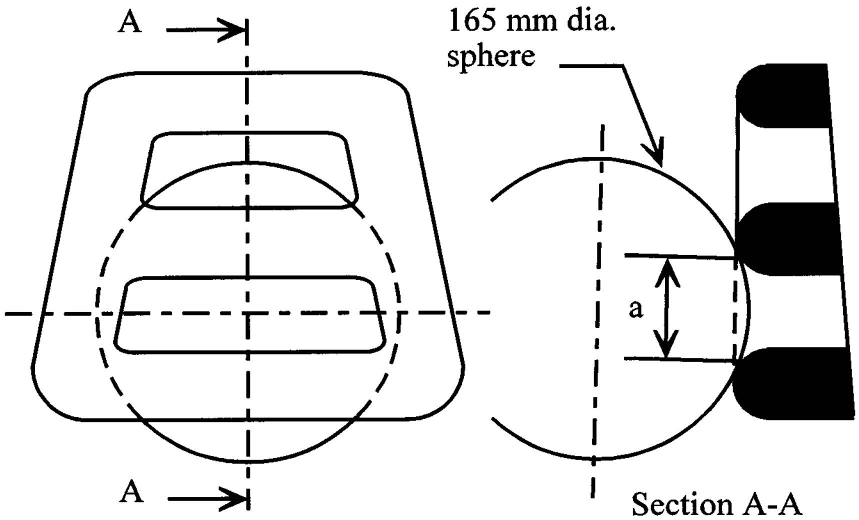

Figure 2 - Measurement of a vertical gap "a".

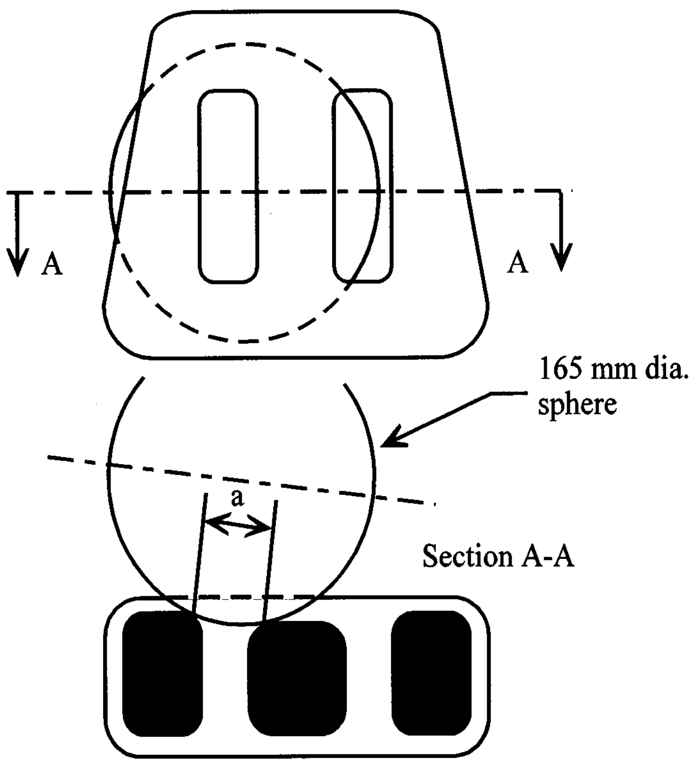

Figure 3 - Measurement of a horizontal gap "a".

Issued on December 22, 2000.

Stephen R. Kratzke,

Associate Administrator for Safety Performance Standards.

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