# Measurement and Evaluation of Head Restraints in 1995 Vehicles

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**ABSTRACT**

Head restraints, which are intended to reduce the risk of neck injury in rear impacts, have been required by Federal Motor Vehicle Safety Standard 202 in new passenger cars since the 1969 model year and in light trucks since the 1992 model year. This standard specifies minimum geometric criteria for head restraint height and width only. To reduce the likelihood of whiplash injury, a head restraint should be behind and close to the back of an occupant's head to provide support in a rear impact. The head restraints in model year 1995 passenger cars and passenger vans were measured to evaluate their proximity to the head of an occupant. Of 164 vehicles measured, only five vehicles (3 percent) were rated as having *good* head restraints. One hundred and seventeen (71 percent) of the vehicles had *poor* restraints, eight were *acceptable,* and 34 were *marginal.* The evaluation considered head restraint geometry relative to the head of an average size male, the restraint's adjustability, and it's ability to lock in place. The results of this evaluation highlight the inadequacy of the present standard's geometric criteria and the need for improved head restraint designs.

**INTRODUCTION**

Whiplash injuries are among the most frequent in crashes and, because of this frequency, their total cost is among the highest. In the United States, between 59 percent and 66 percent of insurance claims for occupant injuries include neck sprains (IRC, 1994). Head restraints, which have been required for the driver and right front passenger in all passenger cars since the 1969 model year and in light trucks since the 1992 model year, are intended to reduce the likelihood of these injuries in rear impacts (49 *CFR* § 571.202).

Although many factors can influence an occupant's risk of neck injury in a rear impact, including the structure and deformation of the rear-end of the vehicle, the characteristics of the seat, and seat belt use, head restraints are considered to be the principal countermeasure. Head restraints have been proven to reduce neck injury risk (Bourbeau et al., 1993; Kahane, 1982; Ollson et al., 1990; O'Neill et al., 1972; Svenssan et al., 1993), but little is known about the optimum vehicle structure, seat, and head restraint characteristics needed to minimize neck injury risk. What is known, however, is that an effective head restraint must be located behind and close to the back of an occupant's head to support it in a rear impact. This geometric relationship of the occupant to the head restraint is necessary but, by itself, may not be sufficient to assure effective protection (Svenssan et al., 1993).

To assess the designs of 1995 model year head restraints, geometric measurements were taken on 164 passenger vehicles. Measurements relative to the head of a seated average size male were obtained using a specially designed head form mounted on a standard H-point machine. Head restraint protection was rated as *good, acceptable, marginal,* or *poor* based on measured head restraint geometry, adjustability, and the restraint's ability to lock in place. Vehicles were selected for measurement to represent popular models of all 1995 makes and series of passenger cars for sale in the United States. The measurements were made at new car dealerships located in Virginia.

The evaluation of head restraint geometry was based on two criteria: head restraint height (the distance down from the top of an occupant's head to the top of the restraint) and head restraint backset (the distance from the back of an occupant's head to the front of the restraint). Although there are no widely used criteria to determine acceptable head restraint geometry, at a meeting in 1994 in Lyon, France, an international ad hoc group for neck protection in rear-end impacts recommended that head restraints have a minimum height corresponding to the top of the head of the 50th percentile adult male

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seated in a car seat. In the current study, it is recommended that a head restraint should be at least as high as the head's center of gravity, which is about 9 cm below the top of the head of an average size male (UMTRI, 1983). Although there are no published criteria for backset, it is generally agreed that this distance should be as small as possible. Backsets greater than 10 cm have been associated with increased symptoms of neck injury in rear-impact crashes (Ollson et al., 1990).

To rate the various head restraint designs, four geometric zones were specified based on head restraint height and head restraint backset (Figure 1). Each zone represents progressively worse geometry. The border values for height (6, 8, 10 cm) and for backset (7, 9, 11 cm) were included with the lower zone.

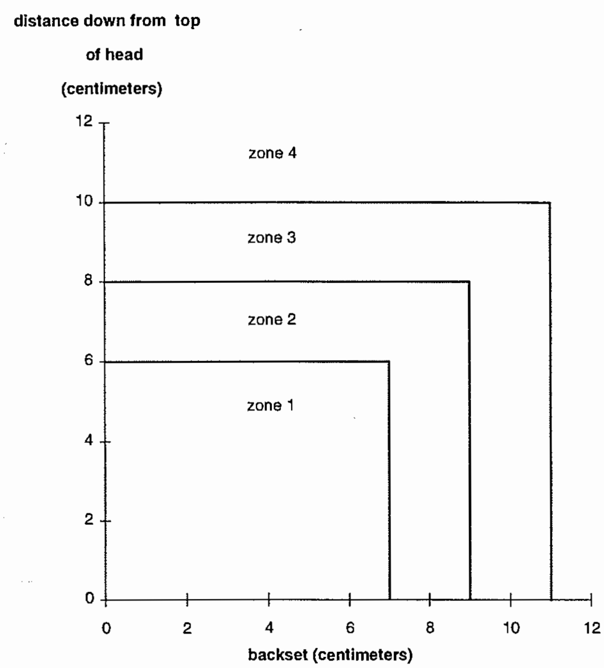


**Figure 1. Head Restraint Geometric Zones**

A restraint was rated as *good* if its geometry put it in zone 1 without adjustment; *acceptable* if it was zone 2 without adjustment or in zone 1 with adjustment that locks in place; or *marginal* if it was zone 3 without adjustment or if it was in zone 2 with locking adjustment; and *poor* if its geometry put it in zone 3 with adjustment or zone 4 regardless of adjustment. The lower ratings for the adjustable-locking restraints reflect the fact that most occupants do not adjust the head restraints (Viano and Gargan, 1995).

## MEASUREMENT METHOD

Measurements of head restraint height and backset were made with a standard H-point machine fitted with a special device that represents the head of an average size male (Figure 2). The head, developed under the sponsorship of the Insurance Corporation of British Columbia (ICBC), includes probes to aid in the measurement of the backset (Figure 3) and height (Figure 4) of the restraint relative to the head.

Measurements were made according to the procedures specified in the *Instruction Manual for the Head Restraint Measuring Device* (ICBC 1995), with two modifications: (1) The legs of the H-point machine were configured in accordance with Federal Motor Vehicle Safety Standard (FMVSS) 208 requirements to approximate the Hybrid III 50th percentile male dummy dimensions (49 *CFR* § 571.208.11.4.3.1).[1] (2) As specified by the *Manual*, measurements were made with the seat back positioned to achieve a torso angle of 25 ± 2 degrees from vertical prior to mounting the head on the H-point machine.[2] However, subsequent testing revealed that in some seats with flexible backs, adding the head to the H-point machine could increase the torso angle by as much as a degree, which reduces the apparent geometric fit of the head restraint to the measurement device. In addition, volunteer testing of some of the measured seats suggested that some people prefer a slightly steeper angle than the 25 degrees specified in Schneider et al. (1983). Therefore, prior to assigning the head restraint to one of the zones in Figure 1, the distance from the top of the head to the top of the restraint was reduced by 0.5 cm and the backset distance was reduced by 1.0 cm. These adjustments improve the ratings of the head restraints. Note that measurements contained in Table 1 are the actual measurements prior to this adjustment.

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[1] The length of the lower leg and thigh segments of the H-point machine were adjusted to 16.3 and 15.8 inches, respectively, instead of the 95th percentile values specified in Table 1 of SAE J826.

[2] This torso angle corresponds to the preferred seated position of volunteers tested by the University of Michigan Transportation Research Institute as part of the development of the average size male dummy (Schneider et al., 1983); the torso angle of the volunteers was measured while seated in a special seat designed to represent the average seat design of four different car models set to the manufacturer's recommended seat back angle. This is the angle to which the Hybrid III 50th percentile male dummy is designed.

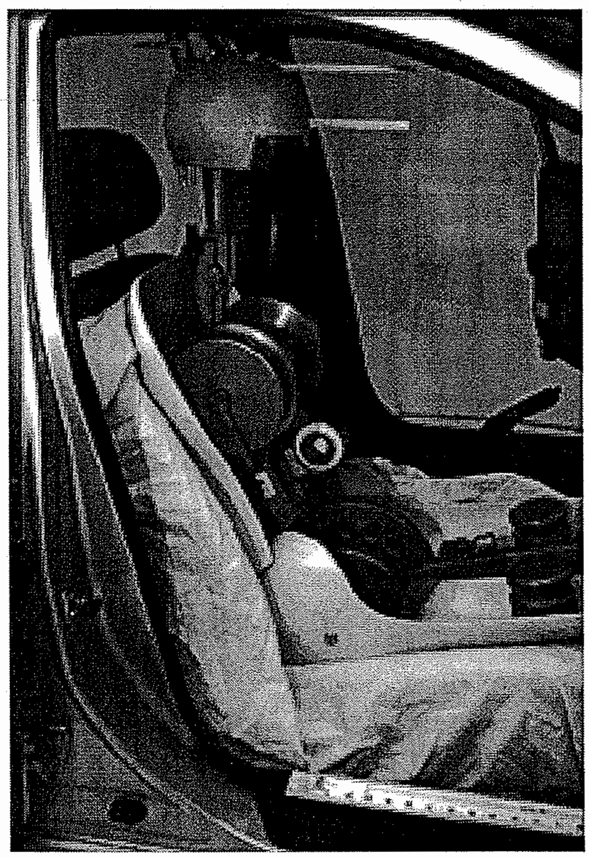

**Figure 2. H-Point Machine with ICBC Head Restraint Measurement Device**

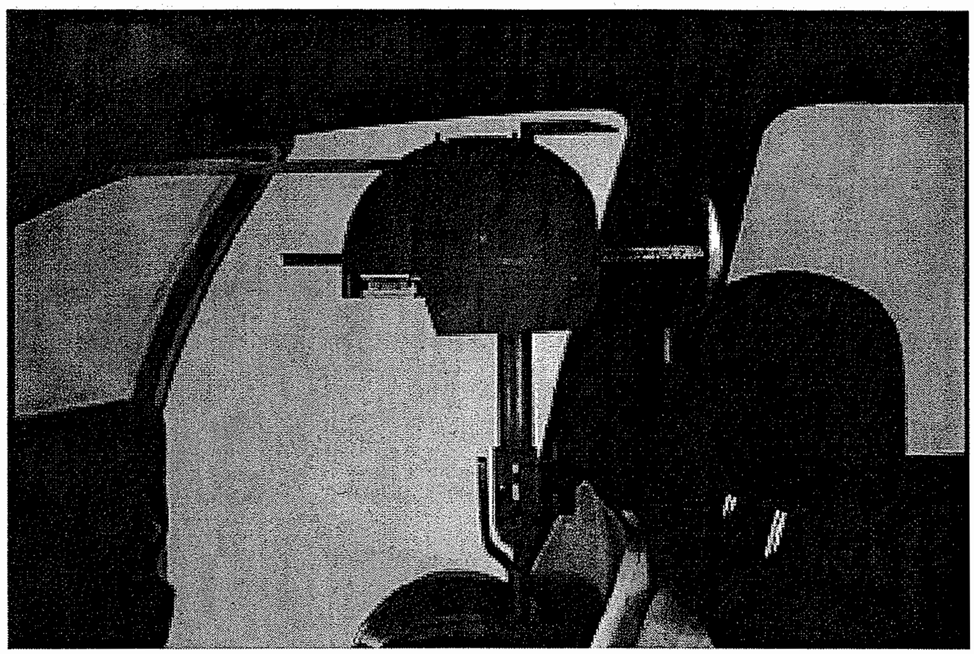

**Figure 3. Head Restraint Backset Measurement**

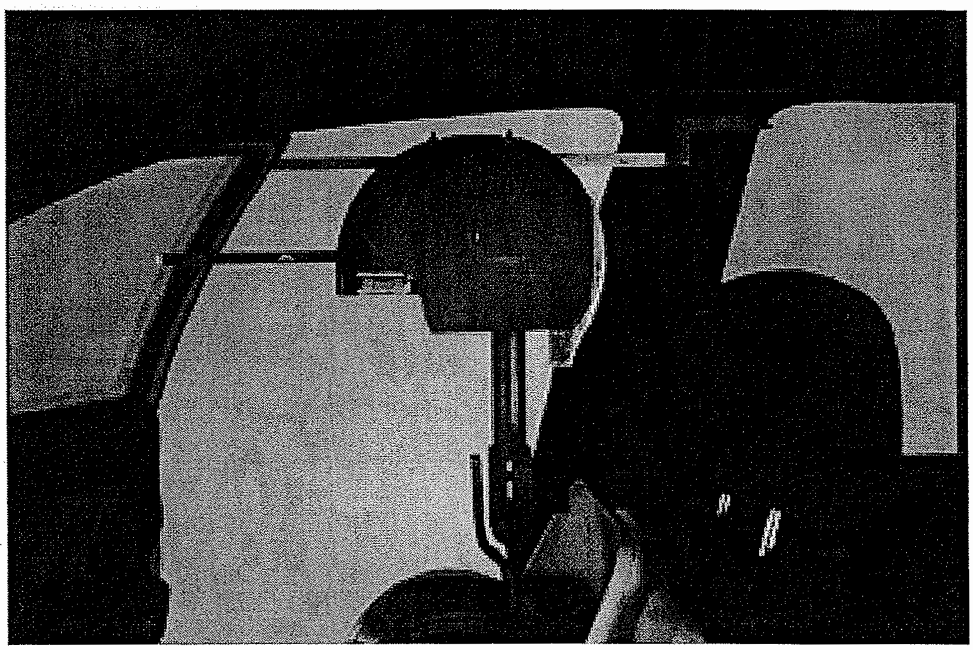

**Figure 4. Head Restraint Height Measurement**

## Vehicle and Seat Preparation

The vehicle was positioned on level ground. To confirm the vehicle attitude, the door sill (front to rear level) and center trunk (side to side level) were used as reference points. Loose floor mats in the passenger seating area were removed. If the seat was equipped with a movable arm rest, it was raised or placed in its stored position; adjustable lumbar supports were fully retracted; and adjustable lateral back supports or lateral thigh supports were set open or as wide as possible. If there were other adjustable components on the seat, they were set to a neutral position and the selected position was recorded on the data sheet. The seat was located in the middle position, which was defined as the position between the extreme forward and rearward seat positions along the track. If there was an even number of positions in which the seat could be located, the middle position was defined as the most rearward stop of the middle two positions.

## H-point Machine Set-up and Installation

After the vehicle and seat had been positioned, the seat was covered with a cotton cloth. The cloth was tucked into the seat joint with a sufficient amount to prevent "hammocking" of the material. All weights were removed from the H-point machine. The lower legs were adjusted to the 50th percentile settings and the upper legs were adjusted to the 10th percentile settings, which were the closest H-point machine settings to the FMVSS 208 requirements. The legs were attached to the H-point machine and were set at number 5 on the knee joint T-bar, which places the center of the knees 10 cm apart. With the legs attached, and the back pan folded forward, the H-point machine was placed in the centerline of the passenger seat. The back pan was straightened to the vehicle seat back.

The feet were placed as far forward as possible with the heels on the floor and the soles of the feet resting on the floor, toe board, or firewall. If necessary, the leg spacing was changed to clear obstructions (e.g., instrument panel fixtures, tunnel width, seat tracks).[1] Changes to the distance between legs for proper feet positioning were recorded. The lower leg weights were attached, the thigh weights were attached, and the H-point machine was leveled. The back pan was tilted forward and the H-point machine assembly was pushed rearward until the seat pan contacted the vehicle seat back. While tilting the back pan forward, a horizontal rearward load of 10 kg was applied by compressing the plunger on the T-bar. The load application was repeated, and, while keeping the spring compressed, the back pan was returned to the vehicle seat back and the spring was released. The H-point machine was level, facing directly forward, and located in the centerline of the seat.

Due to the variability of cushion stiffness and seat back contour, there was no consistent reference for seat back angle among vehicle seats. The seat back was adjusted to provide a consistent occupant posture for each vehicle seat. The head restraint measurements were made with the seat adjusted such that the H-point torso was reclined 25 ± 2 degrees from vertical.

The H-point machine torso angle was measured by placing an inclinometer on the lower brace of the torso weight hanger. As a rough estimate of the seat back position, the seat back was placed such that the torso angle was about 21 degrees before the buttocks and chest weights were added. This angle was varied according to the subjective estimate of the stiffness of the seat cushions. After estimating the seat back position, the right and left buttock weights were installed and then alternately the six chest weights. The two larger chest weights were attached last, flat side down. The H-point machine was leveled and the torso angle measured. If the measured angle was not 25 ± 2 degrees, the chest and buttocks weights were removed, the seat back was re-adjusted, and the steps to position the H-point machine were repeated beginning with tilting the back pan forward and pushing the H-point machine rearward. The torso angle was recorded when it fell within the allowed range.

Tilting the back pan forward to a vertical position, the assembly was rocked from side to side over a 10 degree arc — 5 degrees in each direction. This rocking was repeated twice, while not applying extra vertical or horizontal forces that could cause movement in the seat pan. The back pan was returned to the seat back and the H-point machine was leveled again. The feet were repositioned as follows: Each foot was alternately lifted off the floor, via the instep, until no additional forward foot movement was obtained. When each foot was placed back in the down position, the heel was to be in contact with the floor, and the sole of the foot was to be in contact with the floor, toe board, or firewall. If the seat pan was not level after the feet were repositioned, a sufficient lateral load was applied to the top of the seat pan to level the H-point machine seat pan on the vehicle seat.

**Installation of Head Form**

The head form used to make the measurements is equipped with two probes. The first probe projects horizontally level with the top of the head to provide a reference line for the height of the restraint. The second probe is the shape of the rear profile of the head and neck. It projects horizontally from the back of the head to provide the horizontal distance or backset measurement from the back of the head to the front of the head restraint. The backset probe was installed and pushed flush against the head form. The height probe (vertical measurement probe) was removed from the head form and the knob (to level the head form) was confirmed as finger tight. The head form was lowered in position onto the torso weight hangers and onto the top edge of the channel between the torso weight hangers. The height probe was installed with the bottom of the rear tip level with the top of the head form. The head form was leveled by loosening the rear knob and repositioning the head form using the head form bubble level. The knob was retightened by hand.

### Head Restraint Measurements

The head restraint was positioned into its lowest adjustment. If the head restraint had a tilt option, it was placed in its most rearward adjustment and the tilt option was noted. If the restraint was fixed it was noted. The top probe was pushed rearward until it was positioned directly over the top of the restraint and a tape measure was used to measure the vertical distance between the top of the head restraint and the lower surface of the probe tip. This vertical distance was recorded to the nearest half centimeter. The backset probe was then pushed rearward until the probe profile touched the head restraint. The horizontal distance was recorded in centimeters directly from the scale located on the probe at the center of the head form. If the probe was too high to contact the head restraint, the distance was recorded as "missed". If the head restraint was not fixed, the process was repeated for the highest, most rearward, adjusted position.

### Head Restraint Locking Mechanism Procedure

Some manufacturers provide adjustable head restraints that manually locked in each of the higher positions. However, others do not, apparently relying on dynamic forces of the crash to keep an adjusted head restraint in position. To determine if an adjustable head restraint without a manual locking/unlocking mechanism would support the head of an occupant in the condition of a rear-end impact or if the head restraint could be pushed down by the occupant's head, the following procedure was used. Two of the thorax weights from the H-point machine (about 17 pounds total) were placed on the top of the fully adjusted head restraint. If the restraint was unable to support this weight without lowering to the unadjusted position then a rearward horizontal force was applied to the front of the head restraint. The force was increased in 5 lb increments. The force was applied manually and controlled using a small scale. To distribute the force, it was applied to the center of a metal ruler placed on the front of the restraint. The amount of rearward force required before the head restraint supported the downward load was recorded. A restraint was considered to have a locking mechanism in the loaded condition if 5 lb or less rearward force was required to cause the head restraint to maintain its adjusted position.

## RESULTS

The results of the evaluation are presented in Table 1. The major findings of this study are summarized in the following:

Of the vehicles measured, 26 were equipped with fixed head restraints and 138 with adjustable head restraints.

- Almost three quarters (71 percent) of all head restraints received a poor rating.
- Even among the fixed head restraints, 58 percent have poor geometry (backset greater than 11 cm or distance from the top of the head greater than 10 cm).
- Eighty-five percent of the adjustable restraints have poor geometry when in the down position. When they are fully adjusted up, 36 percent still have poor geometry.
- Less than half of adjustable restraints (43 percent) were equipped with a positive, manual locking mechanism; another 38 percent probably would lock in a crash.
- All adjustable head restraints in vehicles with Japanese nameplates have a positive, manual lock.
- Sixty-nine percent of the restraints unable to maintain upward adjustment were in vehicles with American nameplates.
- Among the vehicles with adjustable restraints with manual or loaded locking mechanisms, 43 percent of the American nameplate vehicles have poor geometry in the up position. Only 21 percent of the Asian and none of the European vehicles have poor geometry in the up position.

## DISCUSSION

Neck strain resulting from a rear impact is an injury that is not yet well understood despite its prevalence. The purpose of a head restraint is to support the head and to reduce the relative motion between the head and the torso during a rear impact. Head restraints can reduce the risk of neck injury in rear impact collisions but their effectiveness is influenced by their geometry (Kahane, 1982). The risk of neck injury can be influenced by many factors other than head restraint geometry, including seat design, safety belt use, and vehicle structure. Also, the effectiveness of a head restraint in any crash can be influenced by occupant posture and whether the head is turned at the time of the impact. Although many factors can influence injury likelihood, a head restraint can not be effective if it is not positioned to support the head of an occupant.

This study shows that many head restraints in new vehicles can not be positioned optimally for even average size occupants. The current federal safety standard for head restraints only specifies minimum geometric criteria. This standard is so weak that a minimum head restraint height in its fully extended position, when measured relative to the anthropometric specifications for the average size male dummy, may be 11 cm below the top of the head, which is below the head's center of gravity. There is no standard seat back adjustment or torso angle for this measurement, no requirement that the restraint lock in the fully extended position, and no minimum horizontal distance from the back of the head. Unfortunately, as this assessment of head restraint geometry for 1995 model cars demonstrates, far too many designs barely meet these inadequate minimums. As a necessary first step in reducing whiplash injury risk in rear impacts, the geometry of head restraints in the vast majority of cars needs to be improved.

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**Table 1**
**Head Restraint Evaluation Measurements — 1995 Models**

| Make | Model | Trim | Locking Type[1] | Tilting[2] | Horizontal[3] Distance Down (cm) | Vertical Distance Down (cm) | Horizontal Distance Up (cm) | Vertical Distance Up (cm) |
|---|---|---|---|---|---|---|---|---|
| | | | | **GOOD** | | | | |
| Honda | Civic Del Sol | S | Fixed | No Tilt | 8.0 | 4.5 | 0.0 | 0.0 |
| Porsche | 911 Coupe | Carrera | Fixed | No Tilt | 7.5 | 6.0 | 0.0 | 0.0 |
| Volvo | 850 | base | Fixed | No Tilt | 5.5 | 5.0 | 0.0 | 0.0 |
| Volvo | 940 4D | base | Fixed | No Tilt | 2.5 | 6.0 | 0.0 | 0.0 |
| Volvo | 960 4D | base | Fixed | No Tilt | 3.0 | 6.0 | 0.0 | 0.0 |
| | | | | **ACCEPTABLE** | | | | |
| BMW | 525 I 4D | | Manual | Tilt | 6.5 | 11.0 | 7.0 | 3.5 |
| BMW | 540 I 4D | | Manual | Tilt | 7.5 | 8.5 | 9.5 | 1.0 |
| Mercedes Benz | E Class 4D | 320 | Manual | Tilt | 9.5 | 10.0 | 7.5 | 1.5 |
| Mercedes Benz | S Class 4D | 320 | Manual | Tilt | 8.0 | 11.0 | 5.5 | 2.5 |
| Mercedes Benz | SL Class | 320 | Manual | Tilt | 8.0 | 12.0 | 7.5 | 6.5 |
| Mercury | Villager GS | minivan | Manual | No Tilt | 8.0 | 12.5 | 7.5 | 6.0 |
| Nissan | Altima | base | Manual | No Tilt | 8.0 | 14.0 | 8.0 | 6.5 |
| SAAB | 900 4D | S | Manual | No Tilt | 3.5 | 11.0 | 2.0 | 5.5 |
| | | | | **MARGINAL** | | | | |
| Acura | Integra 4D | LS | Manual | No Tilt | 11.5 | 13.0 | 10.0 | 8.0 |
| BMW | 325 I 4D | | Loaded | Tilt | 8.5 | 12.5 | 9.5 | 4.5 |
| BMW | 740 IL 4D | | Manual | Tilt | 12.5 | 15.5 | 10.0 | 3.5 |
| BMW | 840 CI 2D | | Fixed | Tilt | 11.0 | 5.5 | 0.0 | 0.0 |
| BMW | M3 2D | | Fixed | No Tilt | 8.5 | 9.5 | 0.0 | 0.0 |
| Cadillac | Brougham/Fltwd 4D | base | Loaded | Tilt | 11.0 | 16.0 | 9.5 | 4.5 |
| Chevrolet | Corvette | base | Fixed | No Tilt | 5.0 | 9.5 | 0.0 | 0.0 |
| Chevrolet | Geo-Prism | base/LSI | Manual | No Tilt | 6.5 | 14.5 | 6.5 | 7.0 |
| Ford | Contour 4D | GL | Loaded | Tilt | 7.5 | 16.5 | 6.5 | 7.0 |
| Honda | Accord 4D | LX | Manual | No Tilt | 10.0 | 13.0 | 9.0 | 8.5 |
| Honda | Civic 2D Coupe | EX | Fixed | No Tilt | 11.0 | 9.0 | 0.0 | 0.0 |
| Honda | Odessey LX | minivan | Manual | No Tilt | 10.0 | 15.0 | 8.5 | 8.0 |
| Honda | Prelude | S | Fixed | No Tilt | 10.0 | 9.5 | 0.0 | 0.0 |
| Hyundai | Elantra 4D | GL | Loaded | No Tilt | 6.0 | 12.5 | 5.0 | 7.0 |
| Jaguar | XJ12 4D | base | Manual | Tilt | 8.5 | 10.5 | 8.5 | 5.0 |
| Jaguar | XJ6 4D | | Loaded | Tilt | 8.5 | 10.0 | 9.5 | 5.0 |
| Lexus | ES 300 4D | | Manual | No Tilt | 8.0 | 16.5 | 6.5 | 7.5 |
| Lexus | LS 400 4D | | Manual | No Tilt | 9.0 | 13.0 | 8.5 | 8.5 |
| Mazda | MPV | minivan | Manual | No Tilt | 18.0 | 19.0 | 10.0 | 7.0 |
| Mazda | MX-3 | | Manual | No Tilt | 9.5 | 12.5 | 10.0 | 7.5 |
| Mercedes Benz | C Class 4D | 220 | Manual | Tilt | 9.0 | 9.5 | 10.5 | 1.5 |
| Mercury | Mystique | GS | Loaded | Tilt | 7.5 | 16.5 | 6.5 | 7.0 |
| Mitsubishi | Eclipse 2D | GST | Manual | No Tilt | 10.0 | 14.5 | 8.5 | 8.5 |
| Mitsubishi | Mirage 2D | LS | Manual | No Tilt | 10.0 | 14.5 | 9.0 | 8.5 |
| Nissan | Maxima | base | Manual | No Tilt | 11.0 | 15.0 | 10.0 | 7.5 |
| Nissan | Quest Wagon | minivan | Manual | Tilt | 9.5 | 13.0 | 9.0 | 6.5 |
| Pontiac | Grand Am 2D | SE | Loaded | No Tilt | 9.5 | 14.5 | 6.0 | 8.5 |
| Subaru | Impreza SW | L | Manual | No Tilt | 10.0 | 14.5 | 7.5 | 8.0 |

**Table 1**
**Head Restraint Evaluation Measurements – 1995 Models (cont'd)**

| Make | Model | Trim | Locking Type[1] | Tilting[2] | Horizontal[3] Distance Down (cm) | Vertical Distance Down (cm) | Horizontal Distance Up (cm) | Vertical Distance Up (cm) |
|---|---|---|---|---|---|---|---|---|
| | | | **MARGINAL** (cont'd) | | | | | |
| Subaru | Legacy 4D | L | Manual | No Tilt | 7.0 | 12.5 | 4.5 | 7.5 |
| Suzuki | Esteem | GLX | Manual | No Tilt | 5.5 | 12.0 | 5.5 | 8.0 |
| Toyota | Camry 4D | LE | Manual | Tilt | 9.0 | 14.5 | 8.0 | 7.5 |
| Toyota | Corolla Sedan | base | Manual | No Tilt | 8.0 | 14.5 | 7.5 | 8.0 |
| Toyota | MR2 | base | Manual | No Tilt | 10.5 | 13.5 | 9.5 | 7.0 |
| Toyota | Supra 2D | SE | Fixed | No Tilt | 10.0 | 9.0 | 0.0 | 0.0 |
| | | | **POOR** | | | | | |
| Acura | Legend 2D | L | Manual | Tilt | 16.5 | 16.5 | 14.0 | 9.0 |
| Audi | 90 4D | | None | Tilt | 14.5 | 12.0 | 10.0 | 3.5 |
| Audi | A6 4D | | Loaded | No Tilt | 13.5 | 14.0 | 10.5 | 5.5 |
| Audi | Cabriolet conv. | base | None | Tilt | 14.0 | 12.5 | 12.5 | 7.0 |
| Audi | S6 Quatro 4D | base | None | Tilt | 15.0 | 13.5 | 12.5 | 2.0 |
| BMW | 318 I 4D | base | Loaded | No Tilt | 3.5 | 15.5 | 4.0 | 9.5 |
| Buick | Century 4D | Special | Loaded | No Tilt | 18.0 | 21.0 | 14.5 | 14.5 |
| Buick | Electra/Pk Av | Park Avenue | None | No Tilt | 18.0 | 23.5 | 15.0 | 17.0 |
| Buick | Estate Wagon | base | Loaded | No Tilt | 18.0 | 18.5 | 14.0 | 13.5 |
| Buick | LeSabre 4D | Custom | Loaded | No Tilt | 18.0 | 24.5 | 18.0 | 19.0 |
| Buick | Regal 4D | Custom | Loaded | No Tilt | 18.0 | 18.0 | 12.0 | 14.0 |
| Buick | Riviera 2D | base | Loaded | No Tilt | 11.5 | 16.5 | 8.5 | 11.0 |
| Buick | Roadmaster | base | Loaded | No Tilt | 17.0 | 17.5 | 14.0 | 13.5 |
| Buick | Skylark 4D | Custom/LTD/ Gd Sport | None | No Tilt | 18.0 | 18.5 | 11.0 | 14.5 |
| Cadillac | Deville 4D | base | Loaded | No Tilt | 11.5 | 12.5 | 11.0 | 7.0 |
| Cadillac | Eldorado 2D | touring | Loaded | No Tilt | 16.0 | 16.5 | 15.0 | 11.5 |
| Cadillac | Seville 4D | SLS | Loaded | Tilt | 15.5 | 17.0 | 13.0 | 12.0 |
| Chevrolet | Astro | minivan | Fixed | No Tilt | 4.0 | 13.0 | 0.0 | 0.0 |
| Chevrolet | Beretta-2D | base | Loaded | No Tilt | 9.0 | 13.5 | 8.0 | 10.0 |
| Chevrolet | Camero | base | Fixed | No Tilt | 10.5 | 15.0 | 0.0 | 0.0 |
| Chevrolet | Caprice-4D | Classic Impala SS | None | No Tilt | 12.0 | 16.0 | 12.0 | 12.5 |
| Chevrolet | Cavalier-4D | base | Loaded | No Tilt | 11.5 | 13.0 | 11.0 | 8.0 |
| Chevrolet | Corsica | base | None | No Tilt | 8.5 | 13.0 | 8.0 | 10.0 |
| Chevrolet | Geo-Metro-2D | base/LSI | Fixed | No Tilt | 4.5 | 11.5 | 0.0 | 0.0 |
| Chevrolet | Lumina | minivan | Loaded | No Tilt | 18.0 | 21.0 | 11.5 | 15.5 |
| Chevrolet | Lumina-4D | base | None | No Tilt | 9.0 | 13.5 | 9.0 | 7.0 |
| Chevrolet | Monte Carlo | LS | Loaded | No Tilt | 11.0 | 15.0 | 10.5 | 8.5 |
| Chrysler | Cirrus | LX | Loaded | No Tilt | 18.0 | 18.0 | 10.5 | 9.5 |
| Chrysler | Concord | | Manual | No Tilt | 18.0 | 18.5 | 10.0 | 9.5 |
| Chrysler | Lebaron | GTC | Loaded | No Tilt | 10.0 | 16.0 | 9.0 | 10.5 |
| Chrysler | LHS | base | Loaded | No Tilt | 18.0 | 19.5 | 13.0 | 11.0 |
| Chrysler | New Yorker | | Loaded | No Tilt | 12.5 | 16.5 | 12.0 | 8.0 |
| Chrysler | Sebring | LX | Manual | No Tilt | 12.5 | 15.0 | 11.0 | 9.0 |
| Chrysler | Town and Country | minivan | Loaded | No Tilt | 15.5 | 16.0 | 14.5 | 11.5 |
| Dodge | Avenger 2D | base | Manual | No Tilt | 11.5 | 15.0 | 10.0 | 9.0 |
| Dodge | Caravan | minivan | Fixed | No Tilt | 10.5 | 14.0 | 0.0 | 0.0 |

**Table 1**
**Head Restraint Evaluation Measurements – 1995 Models (cont'd)**

| Make | Model | Trim | Locking Type[1] | Tilting[2] | Horizontal[3] Distance Down (cm) | Vertical Distance Down (cm) | Horizontal Distance Up (cm) | Vertical Distance Up (cm) |
|---|---|---|---|---|---|---|---|---|
| | | | **POOR** (cont'd) | | | | | |
| Dodge | Intrepid 4D | base | Loaded | No Tilt | 18.0 | 18.0 | 10.0 | 9.0 |
| Dodge | Neon 2D | sport | Loaded | No Tilt | 18.0 | 18.5 | 12.5 | 10.0 |
| Dodge | Spirit 4D | base | None | No Tilt | 18.0 | 18.5 | 9.5 | 12.0 |
| Dodge | Stratus 4D | ES | Loaded | No Tilt | 18.0 | 19.5 | 13.0 | 10.5 |
| Dodge | Viper Conv. | RT/10 | Fixed | No Tilt | 5.5 | 11.0 | 0.0 | 0.0 |
| Dodge/Mits | Stealth 2D | base | Manual | No Tilt | 12.0 | 16.0 | 10.0 | 9.0 |
| Eagle | Summit SW | DL | Manual | No Tilt | 18.0 | 19.0 | 9.5 | 12.0 |
| Eagle | Talon | ESi | Manual | No Tilt | 11.0 | 14.5 | 10.0 | 9.0 |
| Eagle | Vision | ESi | Loaded | No Tilt | 18.0 | 19.0 | 11.5 | 10.0 |
| Ford | Aerostar WGN EXT XLT | minivan | Fixed | No Tilt | 11.5 | 14.0 | 0.0 | 0.0 |
| Ford | Aspire 4D | base | Fixed | No Tilt | 10.0 | 14.0 | 0.0 | 0.0 |
| Ford | Crown Victoria | LX | Loaded | No Tilt | 18.0 | 18.0 | 13.0 | 14.0 |
| Ford | Escort 4D | LX | Manual | No Tilt | 9.0 | 15.5 | 8.5 | 9.5 |
| Ford | Mustang 2D cp | base | Loaded | No Tilt | 18.0 | 18.0 | 11.0 | 15.0 |
| Ford | Probe 2D | base | Fixed | No Tilt | 12.0 | 13.0 | 0.0 | 0.0 |
| Ford | Taurus | GL | None | No Tilt | 18.0 | 18.0 | 9.0 | 12.5 |
| Ford | Thunderbird | LX | None | No Tilt | 18.0 | 20.0 | 12.5 | 15.0 |
| Ford | Windstar LX | minivan | None | No Tilt | 7.5 | 15.0 | 5.0 | 8.0 |
| GMC | Safari | minivan | Loaded | No Tilt | 18.0 | 22.0 | 6.0 | 9.0 |
| Hyundai | Accent 4D | base | Loaded | No Tilt | 9.5 | 14.0 | 8.0 | 9.0 |
| Hyundai | Scoupe 2D | base | Manual | No Tilt | 7.5 | 15.5 | 6.5 | 10.5 |
| Hyundai | Sonata 4D | GL | None | No Tilt | 8.5 | 11.5 | 7.0 | 5.0 |
| Infinity | G20 4D | | Manual | No Tilt | 12.5 | 16.0 | 11.0 | 10.0 |
| Infinity | J30 4D | | Manual | Tilt | 15.5 | 15.0 | 14.0 | 9.5 |
| Infinity | Q45 4D | | Manual | Tilt | 12.5 | 16.0 | 10.5 | 10.0 |
| Jaguar | XJS Conv. | | Fixed | No Tilt | 10.0 | 14.0 | 0.0 | 0.0 |
| Lexus | GS300 4D | | Manual | Tilt | 12.0 | 17.0 | 10.5 | 11.5 |
| Lexus | SC 300 2D | | Manual | Tilt | 10.0 | 14.0 | 8.5 | 10.0 |
| Lexus | SC 400 2D | | Manual | Tilt | 11.0 | 14.0 | 9.5 | 10.0 |
| Lincoln | Continental | base | None | Tilt | 18.0 | 18.5 | 11.0 | 12.5 |
| Lincoln | Mark VIII | base | None | Tilt | 10.0 | 14.5 | 9.0 | 11.0 |
| Lincoln | Town Car | Signature | None | No Tilt | 18.0 | 22.0 | 18.0 | 18.0 |
| Mazda | 626 4D | LX | Manual | No Tilt | 18.0 | 18.0 | 10.5 | 12.0 |
| Mazda | 929 4D | base | Manual | Tilt | 14.5 | 16.5 | 13.0 | 10.5 |
| Mazda | Miata | | Manual | No Tilt | 7.5 | 15.5 | 7.0 | 9.5 |
| Mazda | Millenia | base | Manual | No Tilt | 12.5 | 13.0 | 12.5 | 5.5 |
| Mazda | MX-6 | base | Fixed | No Tilt | 10.5 | 13.5 | 0.0 | 0.0 |
| Mazda | Pretege | DX | Manual | No Tilt | 12.0 | 16.5 | 11.5 | 11.0 |
| Mercury | Cougar | XR7 | None | No Tilt | 18.0 | 20.5 | 13.0 | 15.5 |
| Mercury | Grand Marquis | LS | None | No Tilt | 18.0 | 19.0 | 10.5 | 14.5 |
| Mercury | Sable 4D | GS | None | No Tilt | 18.0 | 19.0 | 10.0 | 14.0 |
| Mercury | Tracer SW | base | Manual | No Tilt | 12.0 | 16.0 | 11.5 | 10.5 |
| Mitsubishi | 3000 GT | base | Manual | No Tilt | 13.0 | 16.0 | 11.0 | 9.0 |
| Mitsubishi | Diamante 4D | LS | Manual | No Tilt | 8.0 | 16.0 | 5.5 | 9.0 |
| Mitsubishi | Galant 4D | LS | Manual | No Tilt | 12.0 | 16.0 | 10.5 | 9.0 |
| Nissan | 200 SX | base/SE | Manual | No Tilt | 12.5 | 13.5 | 12.0 | 8.0 |

**Table 1**
**Head Restraint Evaluation Measurements – 1995 Models (cont'd)**

| Make | Model | Trim | Locking Type[1] | Tilting[2] | Horizontal[3] Distance Down (cm) | Vertical Distance Down (cm) | Horizonta l Distance Up (cm) | Vertical Distance Up (cm) |
|---|---|---|---|---|---|---|---|---|
| | | | **POOR** (cont'd) | | | | | |
| Nissan | 240 SX | base/SE coupe | Manual | No Tilt | 7.0 | 11.0 | 6.5 | 9.0 |
| Nissan | 300 ZX | base | Manual | No Tilt | 6.5 | 16.0 | 4.0 | 9.5 |
| Nissan | Sentra 4D | base | Manual | No Tilt | 16.0 | 17.0 | 14.0 | 9.0 |
| Oldsmobile | 98 4D | Regency Elite | Loaded | No Tilt | 18.0 | 20.5 | 12.0 | 17.0 |
| Oldsmobile | Achieva 4D | S | Loaded | No Tilt | 10.5 | 15.0 | 7.0 | 9.0 |
| Oldsmobile | Aurora 4D | base | Loaded | No Tilt | 18.0 | 18.5 | 6.0 | 13.5 |
| Oldsmobile | Ciera 4D | SL | Loaded | No Tilt | 18.0 | 19.0 | 14.5 | 11.0 |
| Oldsmobile | Cutlass 4D | Supreme SL | None | No Tilt | 11.5 | 13.5 | 7.5 | 6.5 |
| Oldsmobile | Delta 88/88 4D | Royal | Loaded | No Tilt | 18.0 | 23.0 | 15.5 | 17.5 |
| Oldsmobile | Silhouette | minivan | Loaded | No Tilt | 18.0 | 21.0 | 11.5 | 15.0 |
| Plymouth | Acclaim | | None | No Tilt | 18.0 | 18.5 | 9.0 | 12.0 |
| Plymouth | Grand Voyager | minivan | Loaded | No Tilt | 14.0 | 15.0 | 13.0 | 10.0 |
| Plymouth | Neon 4D | base | Fixed | No Tilt | 15.5 | 16.5 | 0.0 | 0.0 |
| Plymouth | Voyager | minivan | Fixed | No Tilt | 10.0 | 12.0 | 0.0 | 0.0 |
| Pontiac | Bonneville | SE | Loaded | No Tilt | 10.5 | 16.0 | 8.5 | 10.0 |
| Pontiac | Firebird | base | Loaded | No Tilt | 10.5 | 14.0 | 10.0 | 9.0 |
| Pontiac | Grand Am 4D | SE | Loaded | No Tilt | 11.0 | 15.0 | 7.5 | 9.0 |
| Pontiac | Grand Prix 4D | SE | None | No Tilt | 12.5 | 12.5 | 13.0 | 8.0 |
| Pontiac | Sunfire 2D | base/SE coupe | Loaded | No Tilt | 11.5 | 11.5 | 11.5 | 8.0 |
| Pontiac | Tran Sport | minivan | Loaded | No Tilt | 13.0 | 16.5 | 11.5 | 11.0 |
| Saab | 9000 4D | CS | None | No Tilt | 5.5 | 13.5 | 4.5 | 10.0 |
| Saturn | SC 2D | SC2 | Loaded | Tilt | 15.5 | 16.5 | 15.0 | 12.0 |
| Saturn | SL 4D | SL2 | Loaded | Tilt | 11.5 | 14.5 | 11.0 | 10.0 |
| Saturn | SW | SW2 | Loaded | No Tilt | 12.0 | 14.0 | 11.0 | 10.0 |
| Suzuki | Swift 2D | base | Fixed | No Tilt | 5.0 | 11.5 | 0.0 | 0.0 |
| Toyota | Avalon 4D | XL | Manual | Tilt | 10.5 | 14.0 | 10.5 | 7.5 |
| Toyota | Celica 2D | ST | Manual | No Tilt | 11.5 | 15.0 | 11.5 | 9.0 |
| Toyota | Paseo 2D | base | Fixed | No Tilt | 12.0 | 13.5 | 0.0 | 0.0 |
| Toyota | Previa 2WD DX | minivan | Manual | No Tilt | 15.0 | 16.5 | 13.5 | 10.5 |
| Toyota | Tercel 2D | base | Fixed | No Tilt | 10.0 | 14.5 | 0.0 | 0.0 |
| Volkswagon | Cabrio | 2D conv | Loaded | Tilt | 14.5 | 16.0 | 11.0 | 10.0 |
| Volkswagon | Golf III 4D | GL | None | No Tilt | 12.0 | 14.0 | 10.5 | 9.0 |
| Volkswagon | GTI 2D | VR6 | None | No Tilt | 11.0 | 15.5 | 9.0 | 9.5 |
| Volkswagon | Jetta | III GL | Loaded | No Tilt | 11.5 | 14.0 | 10.0 | 9.5 |
| Volkswagon | Passat | GLS | None | Tilt | 8.5 | 14.0 | 5.0 | 7.5 |

[1] Locking Type indicates whether adjustable head restraint has a manual lock, no lock, or is likely to stay adjusted in the loaded condition. Fixed restraints have no adjustment.

[2] If the restraint was equipped with a forward tilt adjustment it was noted. All measurements were made with the tilt adjustment in the most rearward position.

[3] If the head restraint was too low to be measured, a maximum horizontal distance of 18 cm was recorded.