INSURANCE INSTITUTE
FOR HIGHWAY SAFETY

NEWS RELEASE

September 18, 2005

TESTS OF SEAT/HEAD RESTRAINTS IN MINIVANS:
FORDS ARE ONLY MODELS TO EARN TOP RATING; MOST SEAT/HEAD RESTRAINTS PROVIDE INADEQUATE PROTECTION AGAINST NECK INJURIES IN REAR CRASHES

ARLINGTON, VA — Seat/head restraint combinations in the Ford Freestar and its twin Mercury Monterey earn good overall ratings. Those in some Dodge Grand Caravan/Chrysler Town & Country models are rated acceptable, based on recent evaluations by the Insurance Institute for Highway Safety (see Attachment 1). However, the seat/head restraints in most current minivan models are marginal or poor, indicating they wouldn't provide adequate protection from whiplash injuries for many people in rear-end collisions.

The ratings are for seat/head restraint designs available in 14 current minivan models. Starting points for the ratings are measurements of head restraint geometry — the height of a restraint and its horizontal distance behind the back of the head of an average-size man. Seats with good or acceptable restraint geometry then are tested dynamically using a dummy that measures forces on the neck. This test simulates a collision in which a stationary vehicle is struck in the rear at 20 mph. Seats without good or acceptable geometry are rated poor overall because they cannot be positioned to protect many people.

Among the seat/head restraints that were tested dynamically, those in the Honda Odyssey are rated marginal overall. All seats in the Chevrolet Uplander (also sold as Buick Terazza, Pontiac Montana SV6, and Saturn Relay) and some in the Grand Caravan/Town & Country and Toyota Sienna are rated poor. These ratings are in addition to the good overall rating for the seats in the Freestar/Monterey and the acceptable rating for the seats in some Grand Caravan/Town & Country models.

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All of these seat/head restraint combinations earn overall ratings based on both geometry and dynamic test results.

Another minivan, the Kia Sedona, has been redesigned for the 2006 model year but isn't yet available. Results for the Sedona will be released early next year.

"Automakers are improving the geometry of their head restraints, compared with the last time we evaluated them," says Institute chief operating officer Adrian Lund. "Still, in this group of minivans the Fords are the only models with good dynamic performance for all of their seat designs. Many of the seat/head restraints we evaluated didn't even get to the testing stage because of marginal or poor geometry. These cannot begin to protect most people in rear-end crashes."

Some seats automatically earn poor ratings: The Institute doesn't test seats with head restraints that are rated marginal or poor for geometry because such seats cannot be positioned to protect many taller people. The seats that weren't tested in this group include all of those in the Chevrolet Astro, GMC Safari, Mazda MPV, and Nissan Quest plus some seats in the Grand Caravan and Toyota Sienna.

"It's disappointing that so many minivan seats are rated poor for rear impact protection," Lund says. "Drivers of minivans spend a lot of time on urban and suburban roads where rear-end collisions are common in stop-and-go traffic. Moms often are behind the wheel, and women are more vulnerable to whiplash injuries so they especially need good seats and head restraints."

Neck injuries are the most common kind reported in automobile crashes and are most likely to occur in rear impacts. Whiplash is the most serious injury reported in about 2 million insurance claims each year, which cost at least $8.5 billion. Such injuries aren't life-threatening, but they can be painful and debilitating.

Rear-end crashes are common events in urban and suburban traffic. For example, in one urban Virginia county 63 percent of daytime crashes on urban interstate highways in 2003 were rear impacts.

When a vehicle is struck in the rear and driven forward, the vehicle seats accelerate occupants' torsos forward. Unsupported, their heads will lag behind the forward movement of their torsos. This differential motion causes the neck to bend back and stretch. The higher the torso acceleration the more sudden the motion, the higher the forces on the neck, and the more likely a neck injury is to occur.

"The key to reducing neck injury risk is to keep the head and torso moving together," Lund explains. "To ensure this happens, a seat and head restraint have to work in concert to support the head, accelerating it with the torso as the vehicle is driven forward in a rear impact. This means the geometry of a head restraint has to be adequate, and so do the stiffness characteristics of the vehicle seat and head restraint."

A head restraint should extend at least as high as the top of the ears of the tallest expected occupant. A restraint also should be positioned close to the back of an occupant's head so it can contact the head and support it early in a rear-end crash.

"But good head restraint geometry by itself isn't sufficient," Lund says. "A seat has to be designed so it doesn't move backward and away from the head during a rear impact. A seat also needs to 'give' so an occupant will sink into it, moving the head closer to the restraint."

Sled test simulates rear-end collision: Overall seat/head restraint ratings are based on a two-step evaluation. In the first step restraint geometry is rated using measurements of height and distance from the back of the head of a test dummy that represents an average-size man. Seats with good or acceptable geometric ratings are subjected to a dynamic test conducted on a crash simulation sled that replicates the forces in a stationary vehicle that's rear-ended by another vehicle of the same weight going 20 mph.

A dummy specially designed to assess rear-end crash protection (BioRID) is used to show how a human would respond and measure the forces on the neck during sim-

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ulated crashes. The sled is a movable platform that runs on fixed rails and can be programmed to re-create the accelerations that occur inside vehicles during real-world crashes.

"The sled test simulates the kind of crash that frequently occurs when one vehicle rear ends another in commuter traffic," Lund says. "People think of head restraints as head rests, but they're not. They're important safety devices. You're more likely to need the protection of a good head restraint in a collision than you are to need other safety devices because rear-end crashes are so common."

The Institute's dynamic ratings of good, acceptable, marginal, or poor are derived from two seat design parameters (peak acceleration of the dummy's torso and time from impact initiation to head restraint contact with the dummy's head) plus neck tension and shear forces recorded on BioRID during the test. The sooner a restraint contacts the dummy's head and the lower the acceleration of the torso and the forces on the dummy's neck, the better the dynamic rating. A seat/head restraint's dynamic rating is combined with its geometric rating to produce an overall rating (see Attachment 2).

End 4-page news release on occupant protection in rear impacts
Attachment 1: Ratings of seat/head restraints in minivan models
Attachment 2: Procedures for rating geometry, dynamic performance

VNR on September 19, 2005 at 10-10:30 am EDT (C) IA 5/Trans. 19; and again on 9/19 at 1-1:30 pm EDT (C) IA 5/Trans. 19; fed in rotation

For more information go to www.iihs.org

ATTACHMENT 1
DYNAMICALLY TESTED SEAT/HEAD RESTRAINTS

Make/model	Seat type	OVERALL RATING	DYNAMIC RATING	GEOMETRY OF SEAT/HEAD RESTRAINT
FORD FREESTAR 2004-06 models	SEATS WITH FIXED HEAD RESTRAINTS	G	G	G
FORD FREESTAR MERCURY MONTEREY 2004-06 models	SEATS WITH ADJUSTABLE HEAD RESTRAINTS	G	G	G
DODGE GRAND CARAVAN CHRYSLER TOWN & COUNTRY 2004-06 models	SEATS WITH ADJUSTABLE LUMBAR & ADJUSTABLE HEAD RESTRAINTS	A	A	A
HONDA ODYSSEY 2005-06 models	ALL SEATS	M	M	A
DODGE GRAND CARAVAN CHRYSLER TOWN & COUNTRY 2004-06 models	SEATS WITHOUT ADJUSTABLE LUMBAR, WITH ADJUSTABLE HEAD RESTRAINTS	P	P	A
CHEVROLET UPLANDER BUICK TERRAZA PONTIAC MONTANA SV6 SATURN RELAY 2005-06 models	ALL SEATS	P	P	A
TOYOTA SIENNA 2005-06 models	SEATS WITH ADJUSTABLE LUMBAR	P	P	A

G GOOD
A ACCEPTABLE
M MARGINAL
P POOR

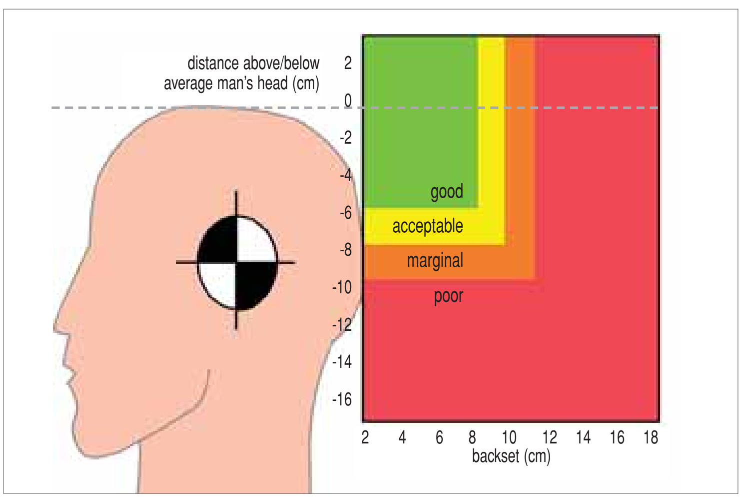
SEAT/HEAD RESTRAINTS NOT DYNAMICALLY TESTED BECAUSE OF INADEQUATE GEOMETRY

Make/model	Seat type	OVERALL RATING	DYNAMIC RATING	GEOMETRY OF SEAT/HEAD RESTRAINT
CHEVROLET ASTRO 2003-05 models	ALL SEATS	P	not tested (see note)	P
DODGE GRAND CARAVAN 2004-05 models	SEATS WITH FIXED HEAD RESTRAINTS	P	not tested (see note)	P
GMC SAFARI 2003-05 models	ALL SEATS	P	not tested (see note)	P
MAZDA MPV 2004-06 models	ALL SEATS	P	not tested (see note)	M
NISSAN QUEST 2004-06 models	ALL SEATS	P	not tested (see note)	M
TOYOTA SIENNA 2005-06 models	SEATS WITHOUT ADJUSTABLE LUMBAR	P	not tested (see note)	M

For each seat/head restraint, REAR-END CRASH PROTECTION is an assessment of occupant protection against neck injury in rear impacts at low to moderate speeds. Such injuries usually aren't serious, but they're frequent. OVERALL RATINGS are based on a two-step evaluation. In the first step head restraint geometry (distance behind and below the head of a seated average-size man) is rated good, acceptable, marginal, or poor. Seats with good or acceptable restraint geometry then are subjected to a dynamic test simulating the forces in a stationary vehicle that's rear-ended by another vehicle of the same weight going 20 mph. Seat/head restraints with marginal or poor geometry aren't tested dynamically because they cannot protect taller people in rear-end crashes. These seats are rated poor overall. In the dynamic test, measurements are recorded on a dummy (BioRID) representing an average-size man. BioRID is designed specifically for rear-end testing at low to moderate speeds. The DYNAMIC RATINGS are derived from two seat design parameters (peak acceleration of the dummy torso and time from impact initiation to head restraint contact with the dummy head) plus tension and shear forces recorded on BioRID's neck during the test. Overall ratings are based on both geometric measurements and dynamic results.

PROCEDURES FOR RATING SEAT/HEAD RESTRAINTS

The International Insurance Whiplash Prevention Group developed the dynamic test criteria to rate the performance of the seat/head restraints listed in Attachment 1. The two-step rating procedure, which includes geometric measurements and a dynamic test, is described below.



The geometry of head restraints is measured in relation to the head of an average-size adult man (top photo shows measuring device). On the basis of these measurements, head restraint geometry is rated good, acceptable, marginal, or poor. These geometric measurements are the first step toward overall ratings of seat/head restraint combinations.

Geometric ratings: A head restraint prevents neck injury by supporting an occupant's head and neck so they can be accelerated together with the torso as the seat is accelerated forward in a rear-end crash. To accomplish this, a head restraint must be close to an occupant's head. Therefore, the first step in rating a seat/head restraint is to measure the height of the restraint and its horizontal distance to the back of the head (backset), using a test device that represents an average-size adult man. For adjustable head restraints that lock in position, measurements are taken in both the highest and lowest positions. The middle of these two positions is used to determine the geometric rating. Procedures for deriving the geometric ratings of good, acceptable, marginal, or poor are specified in the Research Council for Automotive Repairs publication, *Procedures for Evaluating Motor Vehicle Head Restraints* (2001).

Seats with head restraints that are rated marginal or poor, based on geometry, aren't evaluated any further. They're assigned overall ratings of poor because their geometry is inadequate.

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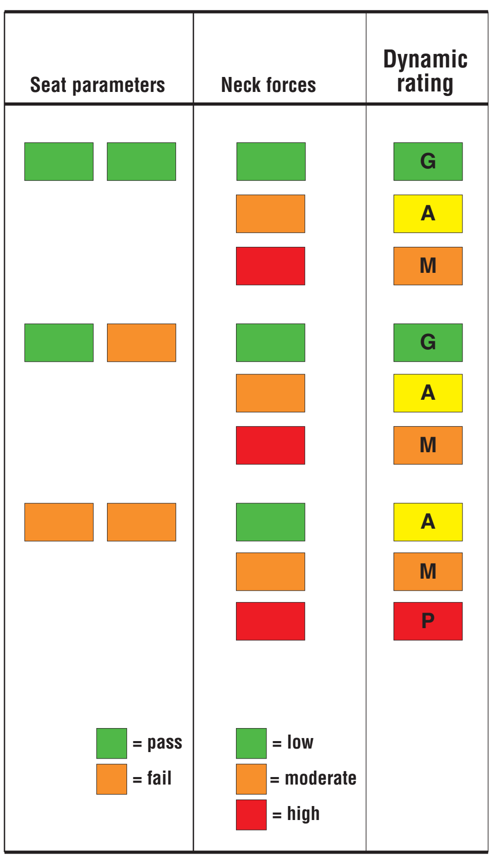
Dynamic ratings: Seat/head restraints with geometry rated good or acceptable are tested in a simulated rear impact conducted on a sled to assess how well the seats support the torso, neck, and head of a BioRID dummy (see next page). The test simulates a rear-end crash with a velocity change of 10 mph, approximately equivalent to a stationary vehicle being struck at 20 mph by a vehicle of the same weight.

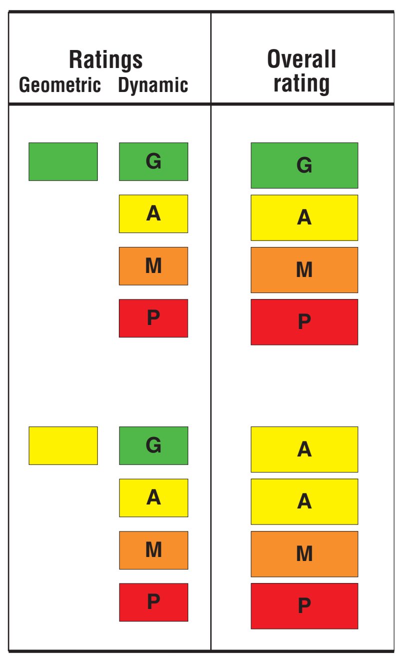
A seat/head restraint's dynamic rating depends on performance in the sled test. There are two sets of criteria for evaluating performance. The first criteria are the two seat design parameters, time to head restraint contact (must be ≤ 70 ms to pass) and torso acceleration (must be ≤ 9.5 g to pass). The second set of evaluation criteria are the maximum neck shear force and maximum neck tension measured on BioRID during the test. These neck forces (classified low, moderate, or high) indicate how well or how poorly an occupant's head and neck would be supported in a rear impact at low to moderate speed. A seat that passes at least one of the seat design parameters and has low neck forces earns a dynamic rating of good. The chart (below left) shows how a dynamic rating is derived from the measures recorded during the sled test.

Overall ratings: Then the geometric rating (see previous page) and the dynamic rating are combined to produce a seat/head restraint combination's overall evaluation (below right). As noted on the previous page, seats with head restraints rated marginal or poor for geometry aren't tested dynamically. They're assigned overall ratings of poor because of inadequate geometry.

DYNAMIC RATINGS
Derived from seat parameter and neck force results



OVERALL RATINGS
Derived from both geometric and dynamic ratings



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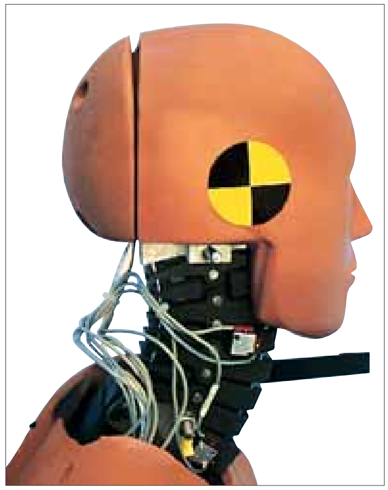
BIORID TEST DUMMY

Dynamic testing of seat/head restraints requires a dummy with a realistic spine and neck. Until the development of BioRID, or biofidelic rear impact dummy, existing dummies had rigid spines and necks that didn't interact with vehicle seats the way human spines and necks do. BioRID was developed for rear testing by a consortium of Chalmers University, restraint maker Autoliv, Saab, and Volvo. This dummy, representing an average-size man, has a spine composed of 24 vertebra-like pieces. The spine interacts with vehicle seats during tests in much the same way as a human spine. Plus BioRID's segmented neck can produce the motion observed by human necks in real-world crashes in which vehicles are struck from behind.



CRASH SIMULATION SLED

The device on which dynamic tests of seat/head restraints are conducted is a steel flatbed sled that runs on fixed rails. The sled is moved to simulate vehicle crash accelerations, re-creating the forces on occupants inside vehicles during real-world crashes. The changing acceleration or deceleration over the time duration of a crash is referred to as a crash pulse, and the key aspect of a sled is that it can be programmed to produce specific crash pulses. To evaluate seat/head restraints, vehicle seats and their attached restraints are fixed to the sled, which is accelerated to simulate a stationary vehicle that's rear-ended by another vehicle of the same weight going 20 mph. To accomplish this, compressed air is pumped into a special cylinder, thrusting a ram forward in a pre-programmed pattern of acceleration (crash pulse). Peak acceleration in the sled test is 10 g (5 g mean acceleration), and the duration is 91 ms.