

Special issue: vehicle incompatibility in crashes

# STATUS REPORT

INSURANCE INSTITUTE  
FOR HIGHWAY SAFETY

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IN COLLISIONS WITH  
CARS, SUVs ARE

## **INCOMPATIBLE.**

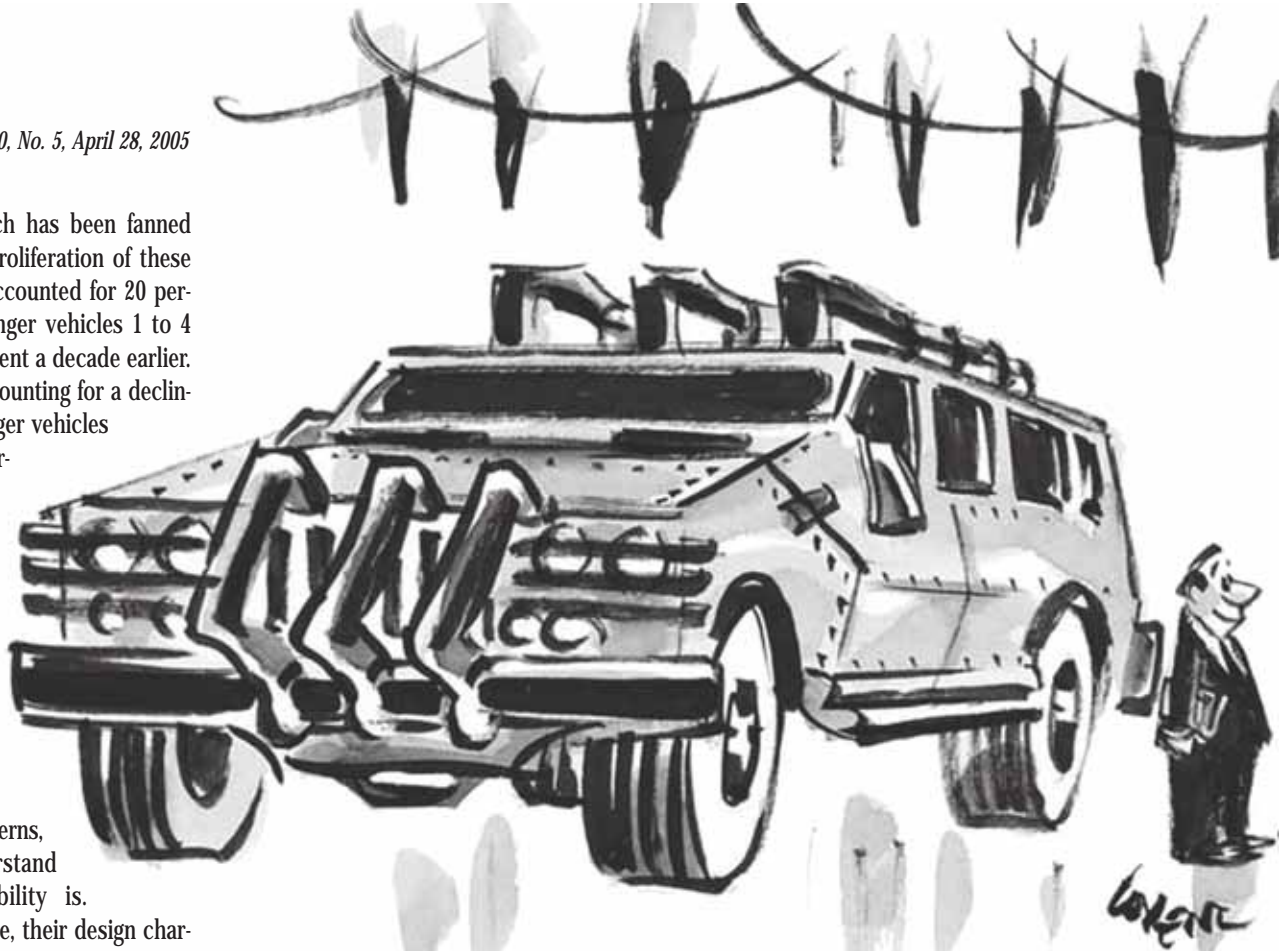
ARE SUVs THAT ARE BIGGER AND  
HEAVIER POSING EVEN MORE RISKS?

A safety concern about large and heavy SUVs is the extent to which they increase the risks for people in cars with which they collide. As the weights and heights of SUVs increase, so does the potential for harm to people in colliding cars. Hence the cartoon image of

the predatory SUV, which has been fanned in recent years by the proliferation of these vehicles. In 2003 SUVs accounted for 20 percent of registered passenger vehicles 1 to 4 years old, up from 7 percent a decade earlier. Meanwhile cars were accounting for a declining proportion of passenger vehicles — 54 percent of 1-to-4-year-old models in 2003, down from 68 percent in 1993.

So is the cartoon image justified? Do design characteristics of newer SUVs (pickups too) increase the risks for car occupants, or are the risks abating?

To address these concerns, it's important to understand what crash incompatibility is. When two vehicles collide, their design characteristics affect injury risk for their own occupants, and some of the same characteristics can affect the risks for people in the colliding vehicle. The first consideration in a crash is how well each vehicle protects its own occupants. Vehicle size and weight



“Nice — but my heart’s still set on a helicopter gunship.”

make a difference, with larger and heavier vehicles usually offering more protection than smaller and lighter ones. Good crumple zones, strong occupant compartments, and state-of-the-art restraint systems also reduce injury risks.

This aspect of the compatibility issue, referred to as self protection, is the most important because it affects outcomes for people in all kinds of crashes, single- as well as two-vehicle. Many lightweight cars, vehicles with poor safety cages and crumple zones, and other passenger vehicles that do a poor job of self protection have higher occupant death rates in all crashes, not just in two-vehicle collisions with larger, heavier vehicles (see *Status Report*, March 15, 2005; on the web at [www.iihs.org](http://www.iihs.org)).

The other important aspect of the compatibility issue is the extent to which vehicle design characteristics increase the risks for people in colliding vehicles. Vehicle weight is one such characteristic, but it's not the only one. Because of their off-road capabilities and, in many cases, how

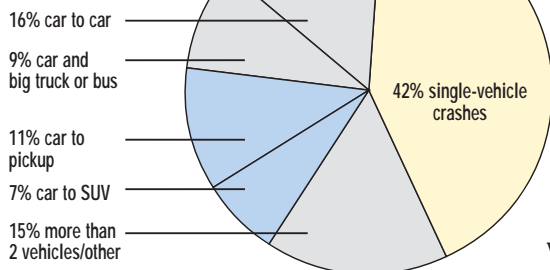
they're constructed, SUVs are higher off the ground than cars, and their front ends are stiffer. Both of these characteristics, like vehicle weight, can influence the risks for occupants of cars that collide with SUVs.

Some of the characteristics that contribute to incompatibility, including weight mismatches, are inherent in any fleet of vehicles. A completely crash compatible fleet isn't achievable, but to the extent possible vehicles should be designed to minimize the mismatches that exacerbate compatibility problems. This hasn't been the case in recent years with the proliferation of bigger, taller, and heavier SUVs.

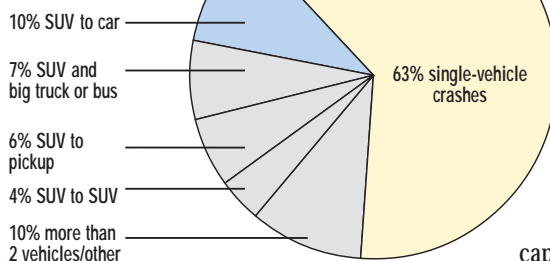
“The extra risks posed by the incompatibilities between cars and SUVs are real, but it's important to note that two-vehicle crashes with SUVs aren't the cause of most car occupant deaths,” Institute president Brian O'Neill points out. “People riding in cars are far more likely to be killed in single-vehicle crashes than in collisions with SUVs.”

Two-vehicle collisions between cars and SUVs or pickups accounted for 18 percent of occupant deaths in 1999-2002 model cars during 2000-03. Nearly the same proportion of car occupant deaths (16 percent) occurred in crashes with other cars. And it isn't as if no

Distribution of **CAR OCCUPANT DEATHS**, 1999-2002 models during 2000-03:

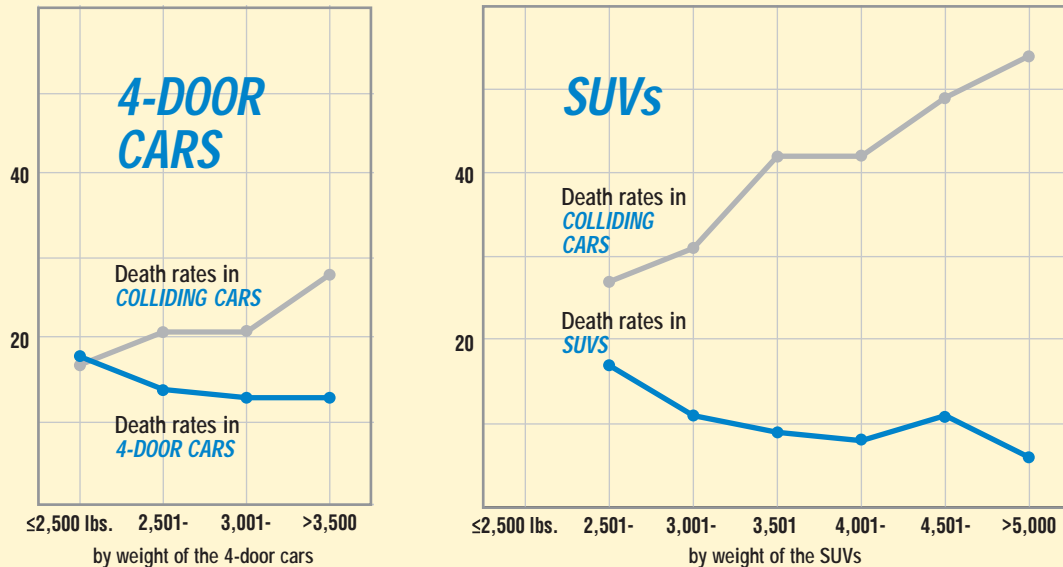


Distribution of **SUV OCCUPANT DEATHS**, 1999-2002 models during 2000-03:



## FATAL TWO-VEHICLE CRASHES

Deaths in 1999-2002 model 4-door cars and SUVs during 2000-03, per million registered years, and deaths in the cars (all model years) with which the 4-door cars and SUVs collided



SUV occupants die in crashes with cars — about 10 percent of such deaths do occur in two-vehicle crashes with cars. By far the biggest shares of deaths in both cars and SUVs (42 percent in cars, 63 percent in SUVs) occur in single-vehicle crashes.

“This doesn’t mean we shouldn’t worry about vehicle design incompatibilities,” O’Neill says. “We need to do whatever we can to minimize the adverse consequences for the car occupants, but we should keep this issue of crash incompatibility in perspective and avoid overstating the consequences.”

**Cars versus SUVs:** To address the extent to which various vehicle types contribute to crash incompatibilities and how this problem has changed over the years, Institute researchers computed deaths per million registered vehicle years in collisions involving two passenger vehicles by vehicle type and weight. Rates are for 1999-2002 models during 2000-03 and 1989-92 models during 1990-93. Data are from the federal government’s Fatality Analysis Reporting System, and registration counts are from The Polk Company.

Because the denominators are registered vehicles, the death rates are influenced by both the frequencies and outcomes of crashes.

Ideally for crash compatibility studies, deaths per number of crashes would be preferred. However, reliable information isn’t available on crashes by vehicle type and weight.

To address self protection, the researchers computed deaths per million registered years in cars, SUVs, and pickup trucks by vehicle weight. To represent the risks to people in other vehicles, the researchers also computed death rates in cars that collided with the various vehicle types.

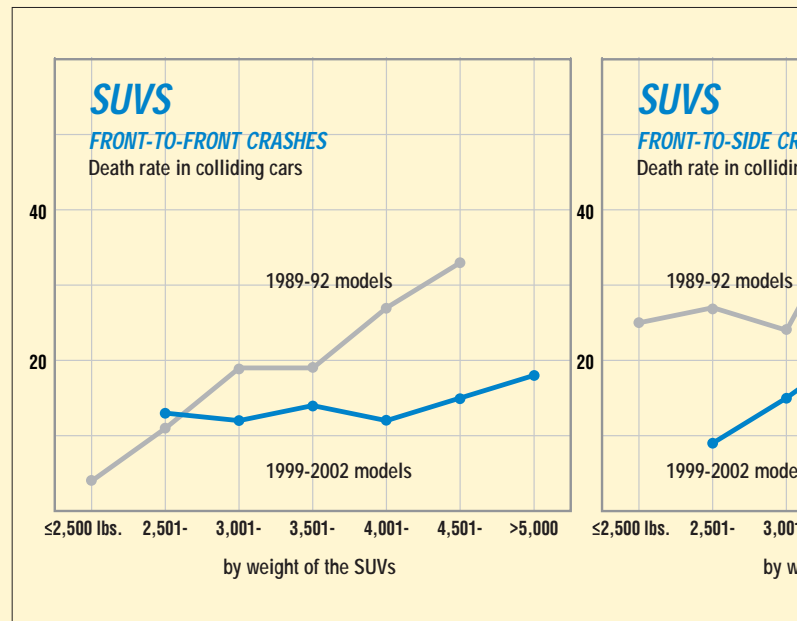
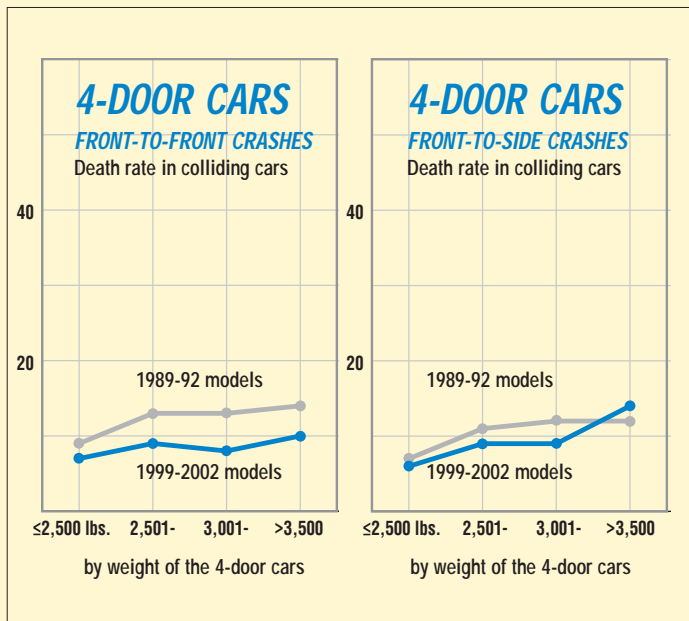
Occupant death rates were lower in all but the lightest SUVs that crashed with cars than in four-door cars of similar weight that collided with other cars. But the differences were greater — and in the opposite direction — in those other cars. Their occupant death rates were much higher in crashes with SUVs than with four-door cars. The car occupant death rates went up as the weights of the SUVs and four-door cars went up, but the increase by weight was much steeper when the collision was with an SUV.

Pound for pound, the SUVs pose more risk than cars. In collisions involving four-door cars weighing 3,501 to 4,000 pounds and other cars, for example, the death rate in the other cars during 2000-03 was 28 per million

*By far the biggest shares of occupant deaths in both cars and SUVs occur in single-vehicle crashes, not collisions involving two or more vehicles. This doesn’t mean that vehicle incompatibilities in crashes aren’t important safety concerns. They are, but it does mean we should keep the incompatibility issue in perspective.*

## FATAL TWO-VEHICLE CRASHES,

Deaths in cars (all model years) that crash with 4-door cars, SUVs, or pickups, per million registered



registered years of the four-door cars. The rate went up to 42 per million in collisions with SUVs in the same 3,501 to 4,000 pound weight range.

“This is the crux of the current debate about crash incompatibility,” O’Neill points out. “Some characteristics of vehicles beyond their weights increase the risks for people in other

vehicles, and the problem is worse in some crash configurations than in others.”

**Front versus side:** Death rates in cars that collide with four-door cars don’t vary much according to the direction of the impact. For example, the death rate in cars in collisions with four-door cars weighing 2,501 to 3,000 pounds during 2000-03 was 9 per million regis-



tered years of the four-door cars, whether the other cars were hit in the front or the side. But the situation was different for people in cars that collided with SUVs. They were almost always worse off when the SUVs hit them in the side than in the front. This was true for SUVs in all weight groups except the lightest one. For example, in frontal crashes with SUVs weighing 4,001 to 4,500 pounds the death rate in colliding cars was 12 per million SUV years during 2000-03. But in cars hit in the side by SUVs in the same weight range, the car occupant death rate was almost twice as high (23 per million).

“There’s not a lot of side structure to protect occupants,” O’Neill explains, “so when cars are struck in the side and the principal impact is above the doorsill, which is what happens when the striking vehicles have tall front ends like SUVs, the predictable result is that the people in the cars fare

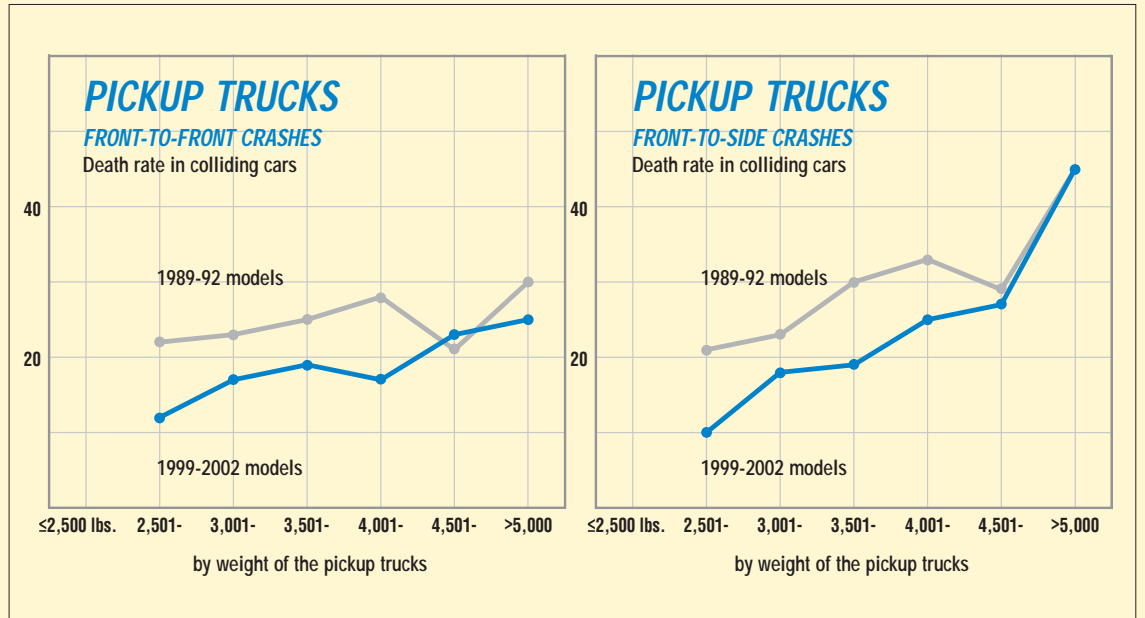
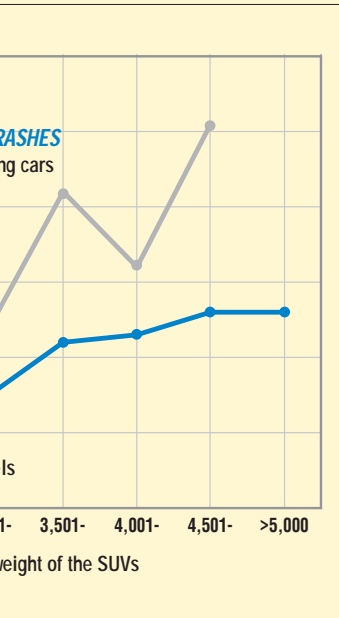
poorly. Their heads are at extra risk in side impacts because of the height of the SUVs. Still the death rates in cars struck in the sides by SUVs were lower during 2000-03 than they were a decade earlier, so there has been some improvement.”

The pattern during 2000-03 was somewhat different in crashes of cars and pickup trucks. Car occupant death rates were about the same whether the impact was front-to-front or front-to-side. The exception involves pickups weighing more than 5,000 pounds. The death rate in cars in side impacts with these pickups during 2000-03 was almost twice as high as the rate in front-to-front crashes (45 deaths per million registered pickup years versus 25 per million).



# FRONT VERSUS SIDE IMPACTS

and years of each vehicle type, 1989-92 models during 1990-93 and 1999-2002 models during 2000-03



*"No radio, but there's an orchestra pit."*

Even though many SUVs and pickups have similar front-end designs and heights, they differ somewhat in terms of the risks they pose to people in the cars they hit in the front. It isn't known how much of this difference is because of differences in where the two vehicle types are driven. It's possible, for example, that pickups are driven more miles on rural roads, compared with SUVs, so they're involved more often than SUVs in front-to-front crashes on two-lane roads.

**Newer versus older vehicles:**

In virtually every vehicle type and weight category, occupant death rates were lower during 2000-03 than a decade earlier. The rates were lower not only among people traveling in each vehicle type but also among people in colliding cars. In cars that collided with SUVs weighing 3,501 to 4,000 pounds, for example, the death rate during 1990-93 was 69 per million SUV years. A decade

## SELF PROTECTION

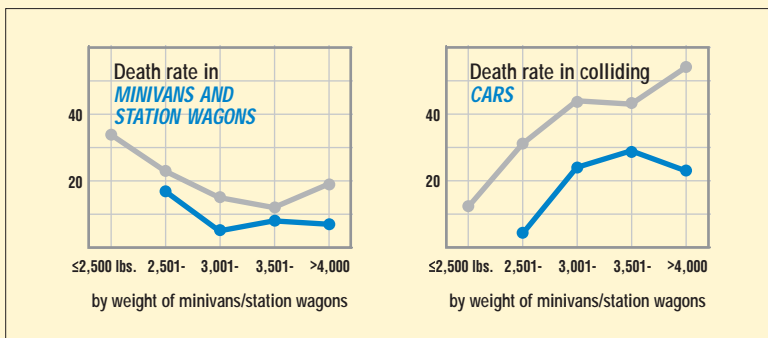
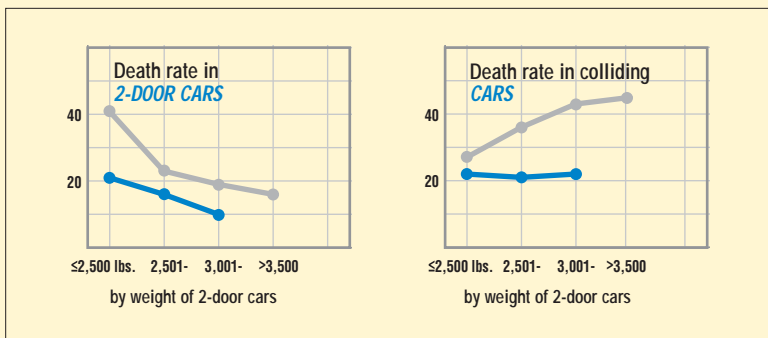
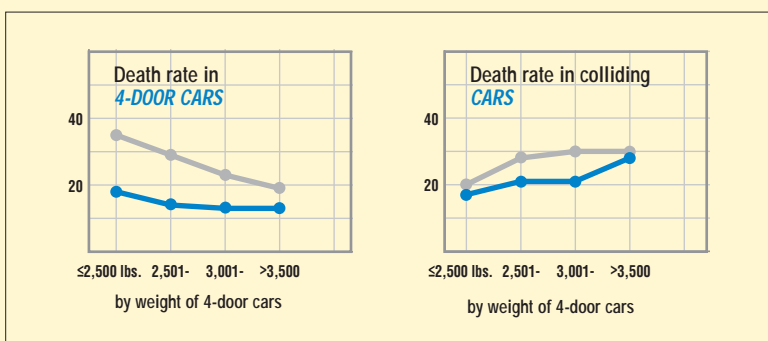
Deaths in cars, minivans, and station wagons per million registered years of each vehicle type, in crashes with cars (all model years)

■ 1989-92 models 1990-93  
■ 1999-2002 models 2000-03

## RISKS IN COLLIDING CARS

Deaths in cars (all model years) in crashes with 4-door cars, 2-door cars, and minivans, per million registered years of each vehicle type

■ 1989-92 models 1990-93  
■ 1999-2002 models 2000-03



From 1990-93 to 2000-03 death rates went down in cars, minivans, and station wagons. Rates also went down in the cars that collided with these vehicles.

later the rate was 42 per million. This represents a 39 percent improvement.

Much of the improvement is likely to be because of better self protection in cars. Belt use has been about 80 percent in recent years, compared with about 50 percent in 1990. More than half of all registered cars had driver airbags in 2000, compared with 3 percent a decade earlier.

Vehicle compatibility also has been improved. Almost all 1989-92 model SUVs were body-on-frame designs derived from light trucks, while many newer SUVs are unibody designs based on cars. The front-end structures of many of the newer designs are lower.

“The sum of these and other improvements is that crash incompatibility is a somewhat lesser problem than it was a decade ago,” O’Neill points out. “It’s still a concern, but it isn’t getting worse, even with the introduction of bigger, heavier SUVs over the past decade.”

### Automakers are addressing incompatibilities:

In the short term, the best approach is to continue to improve self protection for people traveling in all types and sizes of passenger vehicles. Automakers are doing this as the first step in a voluntary commitment to reduce vehicle incompatibilities in both front and side impacts (see *Status Report*, Jan. 3, 2004; on the web at [www.iihs.org](http://www.iihs.org)).

Automakers have agreed to these phases of work to address front-to-side impacts:

**Phase I.** By September 2007, at least 50 percent of each participating manufacturer’s new passenger vehicles will be designed in accordance with one of two head protection options. The first option is to meet the head injury criterion specified in the federal government’s side-into-pole test. The second option is to meet the head protection performance requirements of the side impact test the Institute conducts for consumer information (see *Status Report*, June 28, 2003 on the web at [www.iihs.org](http://www.iihs.org)).

**Phase II.** By September 2009, all passenger vehicles will meet only the head protection performance requirements of the Institute’s test.

**Phase III.** Automakers will conduct crash tests and related research using the Institute’s side impact test to assess the safety benefits of adding performance criteria for other body regions, with specific attention to the thorax and abdomen.

**Phase IV.** Automakers will investigate other opportunities to enhance structural interaction

between vehicles in front-to-side impacts. Emphasis will be on front-end structures and how vehicles meeting the agreements for front-to-front compatibility perform in front-to-side impacts.

Three additional phases of the commitment address incompatibilities in front-to-front crashes:

Phase I. Automakers will begin designing SUVs and pickups according to one of two geometric alignment options. One option is



*"A hundred bucks for a fill-up! We should have left 299 of our 300 horsepower back in the barn."*

for the primary frontal energy-absorbing structures to overlap at least 50 percent with the federally mandated zone for bumper protection on cars. The other option is to add a secondary energy-absorbing structure, connected to the primary one, to achieve the 50 percent overlap. This secondary structure would be designed to reduce structural override of a car in a front-to-front crash.

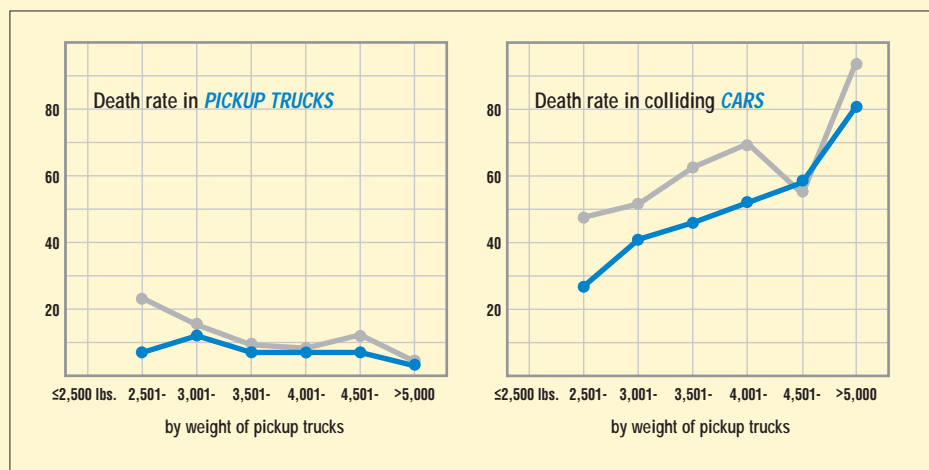
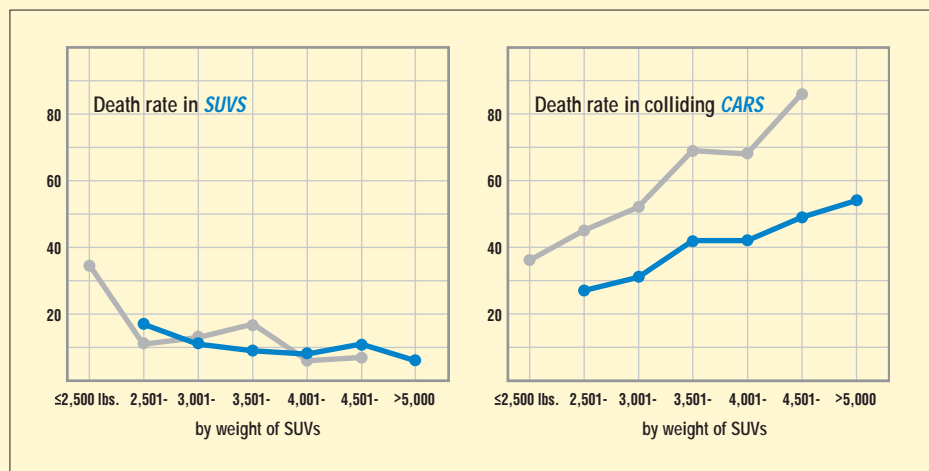
Phase II. Automakers will specify a protocol for dynamic testing to ensure the structural interaction of vehicle front ends in front-to-front crashes.

Phase III. Automakers will investigate testing to determine appropriate front-end stiffness characteristics for larger passenger vehicles like SUVs and pickups in front-to-front crashes with smaller vehicles.

## SELF PROTECTION

Deaths in SUVs and pickup trucks per million registered years of each vehicle type, in crashes with cars (all model years)

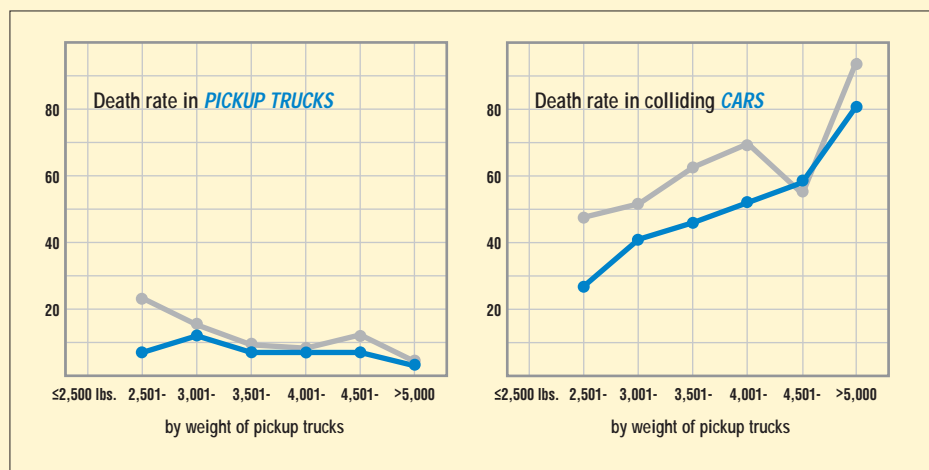
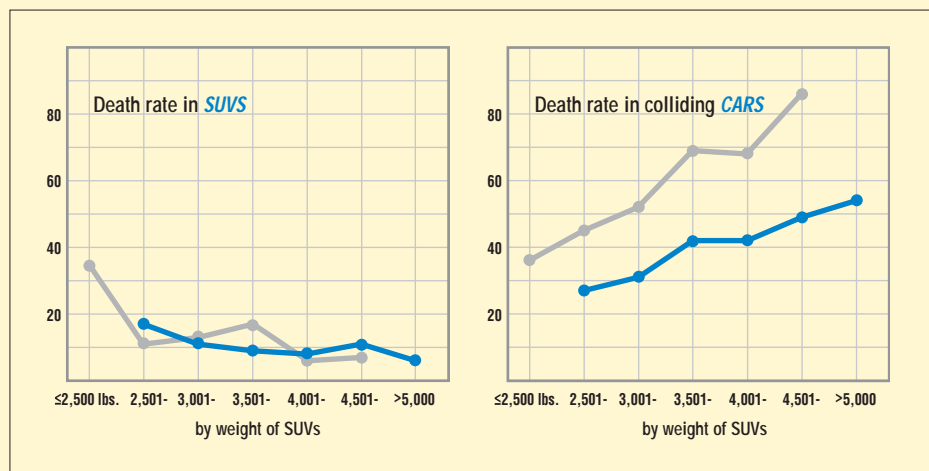
■ 1989-92 models 1990-93  
■ 1999-2002 models 2000-03



## RISKS IN COLLIDING CARS

Deaths in cars (all model years) in crashes with SUVs and pickup trucks per million registered years of each vehicle type

■ 1989-92 models 1990-93  
■ 1999-2002 models 2000-03



"The key is for the automakers to follow through," O'Neill says. "They've completed the agreement for phase one of their commitment to improve vehicle compatibility in both front and side impacts. Now they need to focus just as hard on the second and subsequent phases. In the meantime, the federal

government also is conducting research on crash incompatibilities. So one way or another, the cartoon image of predatory SUVs should recede. We're going to have cars, SUVs, and pickups that do a better job of protecting not only their own occupants but also people in the colliding cars."

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## SPECIAL ISSUE

This special issue focuses on vehicle incompatibilities in crashes. Recent special issues have focused on:

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# FATAL TWO-VEHICLE CRASHES, FRONT VERSUS SIDE IMPACTS

Deaths in cars (all model years) that crash with 4-door cars, SUVs, or pickups, per million registered years of each vehicle type, 1989-92 models during 1990-93 and 1999-2002 models during 2000-03

