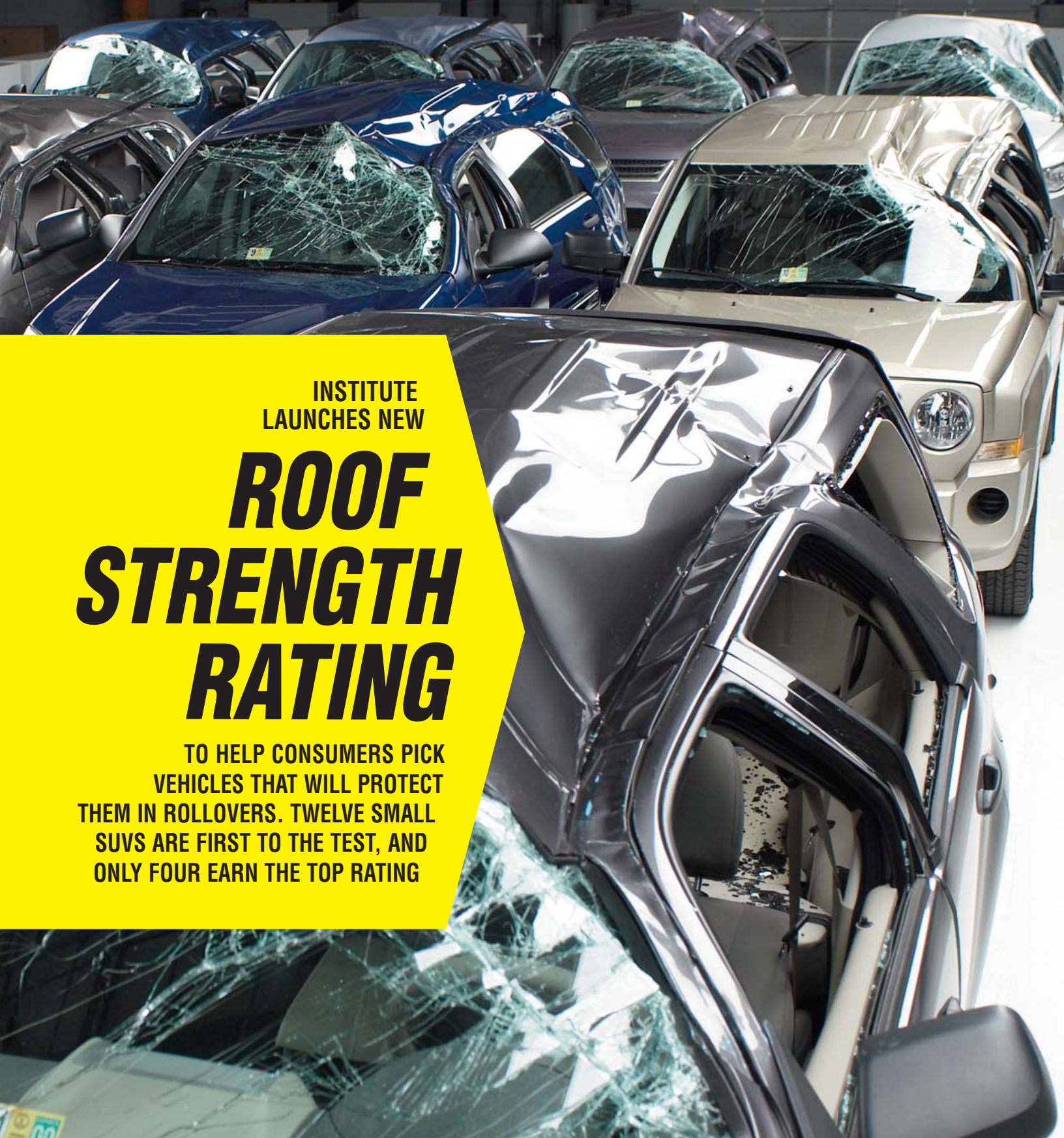
SPECIAL ISSUE: ROOF STRENGTH

STATUS REPORT

INSURANCE INSTITUTE FOR HIGHWAY SAFETY

Vol. 44, No. 3, March 24, 2009



INSTITUTE LAUNCHES NEW

ROOF STRENGTH RATING

TO HELP CONSUMERS PICK VEHICLES THAT WILL PROTECT THEM IN ROLLOVERS. TWELVE SMALL SUVS ARE FIRST TO THE TEST, AND ONLY FOUR EARN THE TOP RATING

of good. The Volkswagen Tiguan has the strongest rated roof, and the Kia Sportage has the weakest among the 2008-09 small SUVs evaluated. This new rating system is based on Institute research showing that occupants in rollover crashes benefit from stronger roofs (see p. 4 and *Status Report*, March 15, 2008; on the web at iihs.org). Vehicles rated good must have roofs that are more than twice as strong as minimum federal safety standards require.

The Tiguan, Subaru Forester, Honda Element, and Jeep Patriot earn good ratings. The Suzuki Grand Vitara, Chevrolet Equinox, Toyota RAV4, Nissan Rogue, and Mitsubishi Outlander are rated acceptable. Roofs on the Honda CR-V and Ford Escape are marginal, and the Kia's is poor.

"We anticipate that our roof strength test will drive improved rollover crash protection the same way that our frontal offset and side impact consumer test programs have led to better protection in these kinds of crashes," says Institute president Adrian Lund.

Institute research indicates that roofs have gotten stronger during the past few years. Part of the reason is that manufacturers have made structural improvements to earn better front and side ratings in Institute crash tests. Strong A and B pillars help prevent intrusion in these types of crashes and also help hold up the roof.

"It's not surprising that Volkswagen and Subaru earn good ratings in our new roof test because these automakers were among the first to ace our front and side tests," Lund points out.

More than 10,000 people a year are killed in rollovers. When vehicles roll, their roofs hit the ground, deform, and crush. Stronger roofs crush less, reducing the risk that people will be injured by contact with the roof itself. Stronger roofs also can prevent occupants, especially those who aren't using belts, from being ejected through windows, windshields, or doors that have broken or opened because the roof has deformed. Roofs that don't collapse help keep people inside vehicles as they roll.

Any vehicle can roll over in a crash, but the problem is worse in some kinds of vehicles than others. About 25 percent of occupant deaths in crashes of cars and minivans involve rolling over. This proportion jumps to 59 percent in SUVs.

The best way to prevent the deaths is to keep vehicles from rolling over in the first place. Electronic stability control is significantly reducing rollovers, especially fatal single-vehicle ones (see *Status Report*, June 13, 2006; on the web at iihs.org). When vehicles do roll, side curtain airbags help protect the people inside. Belt use is essential.

GOOD

VW TIGUAN

THE TIGUAN HAS THE STRONGEST ROOF OF THE 12 RATED SUVS. ITS ROOF CRUSHED LESS THAN 2 INCHES WHILE WITHSTANDING A FORCE OF 15,000 POUNDS. THAT'S 4 TIMES THE TIGUAN'S WEIGHT.

In the Institute's roof strength test, a metal plate is pushed against one side of a roof at a constant speed. To earn a good rating, the roof must withstand a force of 4 times the vehicle's weight before reaching 5 inches of crush. This is called a strength-to-weight ratio. For an acceptable rating, the minimum required strength-to-weight ratio is 3.25. A marginal rating value is 2.5. Anything lower than that is poor.

The small SUVs that did well in the Institute's new test have roofs that are 2.5 to 3.5 times stronger than the minimum federal safety standard for roof strength. The National Highway Traffic Safety Administration has proposed a new standard, but it wouldn't be as tough as the Institute recommends (see p. 6).

"Our research shows that a strength-to-weight ratio of 4 reflects an estimated 50 percent reduction in the risk of serious and fatal injury in single-vehicle rollover crashes compared with the current federal standard of 1.5," Lund explains.

A good roof strength rating will be a new requirement to earn the Institute's *TOP SAFETY PICK* award for 2010. This is the second time criteria for this award have been tightened since the first winners were announced in 2005 (see *Status Report*, Dec. 17, 2006; on the web at iihs.org). Availability of electronic stability control became a requirement starting with 2007s.

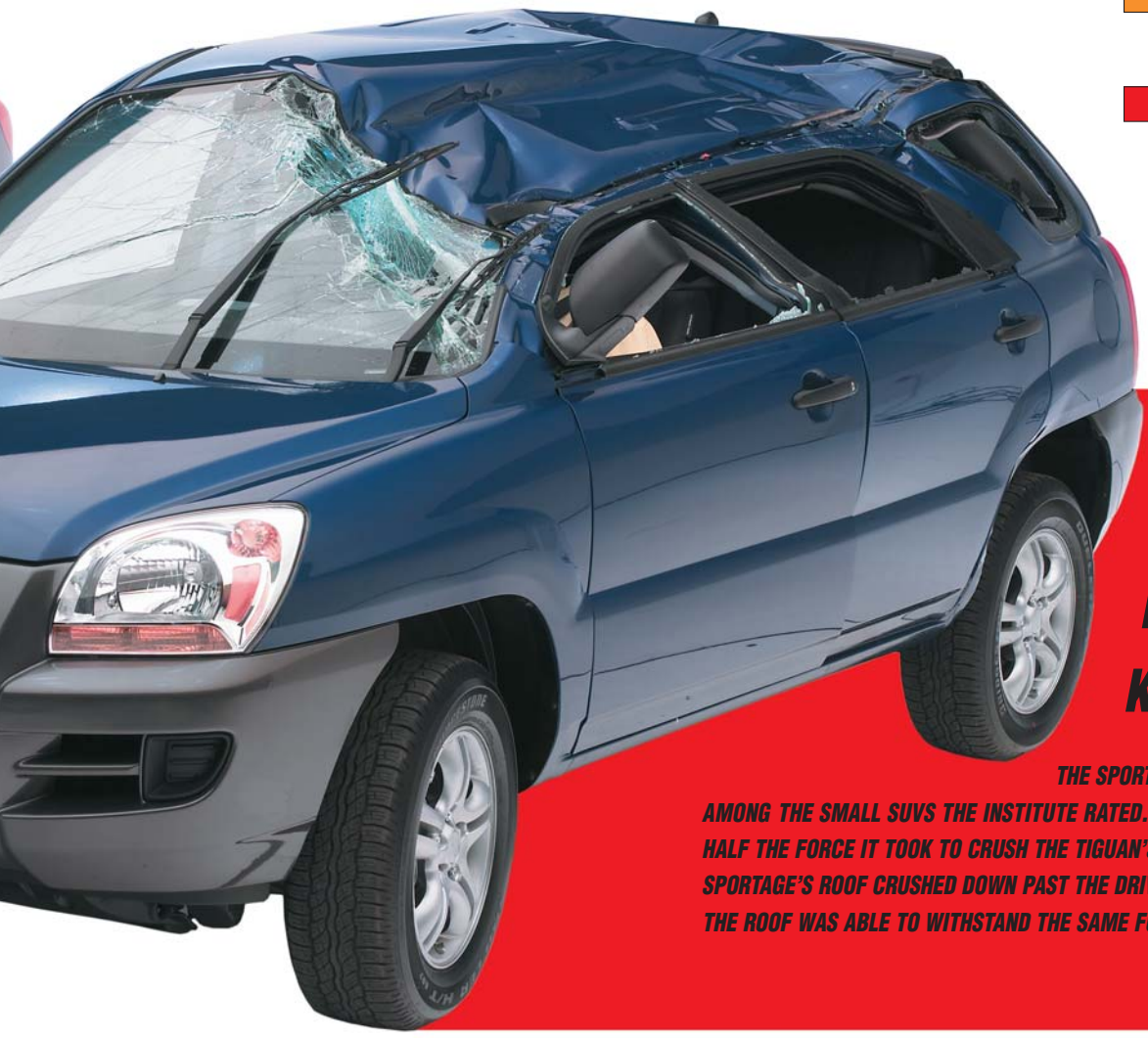
"Adding *TOP SAFETY PICK* criteria means we'll see fewer winners in 2010," Lund says. A record 73 vehicles have qualified for the 2009 award so far, and 8 of the 2009 winners are among the 12 small SUVs the Institute just tested for roof strength. However, only 3 of the 8 — Tiguan, Forester, and Element — have the roof strength to qualify for next year's award.

Next the Institute will assess roof strength of mini and midsize cars.

ROOF STRENGTH

G	VOLKSWAGEN TIGUAN
G	SUBARU FORESTER
G	HONDA ELEMENT
G	JEEP PATRIOT
A	SUZUKI GRAND VITARA
A	CHEVROLET EQUINOX PONTIAC TORRENT
A	TOYOTA RAV4
A	NISSAN ROGUE
A	MITSUBISHI OUTLANDER
M	HONDA CR-V
M	FORD ESCAPE MAZDA TRIBUTE MERCURY MARINER
P	KIA SPORTAGE HYUNDAI TUCSON

GOOD
ACCEPTABLE
MARGINAL
POOR



POOR

KIA SPORTAGE

THE SPORTAGE HAS THE WEAKEST ROOF AMONG THE SMALL SUVS THE INSTITUTE RATED. IT CRUSHED TO 2 INCHES WITH HALF THE FORCE IT TOOK TO CRUSH THE TIGUAN'S ROOF THE SAME DISTANCE. THE SPORTAGE'S ROOF CRUSHED DOWN PAST THE DRIVER'S HEAD RESTRAINT BEFORE THE ROOF WAS ABLE TO WITHSTAND THE SAME FORCE AS THE TIGUAN.

STRONG ROOFS ALSO BENEFIT SMALL CARS

Last year, Institute research indicated that stronger roofs on SUVs reduce the risk of driver injury in rollovers. Building on that, the Institute offers new evidence that drivers of passenger cars also benefit from stronger roofs.

Before the SUV study, there was no conclusive evidence tying vehicle roof strength to occupant protection in rollovers (see *Status Report*, March 15, 2008; on the web at iihs.org). In that study researchers tested 11 midsize SUVs in a procedure similar to what the federal government has required automakers to conduct to assess roof strength. Then the researchers related the findings to the real-world death and injury experience of the same SUVs in single-vehicle rollovers, finding that injury risk went down as roof strength increased.

In a follow-up, researchers subjected 12 small 4-door cars to the same roof crush tests and examined the results of 20,459 single-vehicle rollover crashes involving the same car models. The main finding is that the cars with the strongest roofs reduced ejection risk by as much as 39 percent compared with the vehicles that had the weakest roofs. The strongest roofs in this study reduced the risk of sustaining a fatal or serious injury by about 35 percent.

"There's no evidence that roof strength has a different benefit for people in SUVs compared with people in cars," says Institute president Adrian Lund. "While it's true that SUVs are more frequently involved in rollover crashes, cars roll, too, and the consequences often are deadly. Both types of vehicles benefit from stronger roofs that can prevent people from being ejected in the first place. For occupants who aren't ejected, stronger roofs reduce the chances that they'll be injured or killed."

Manufacturers have built cars to meet the same federal roof standard since 1973, while the standard for passenger vehicles other than cars took effect in 1994. The National Highway Traffic Safety Administration (NHTSA) has proposed changes to better protect people, including the occupants of pickup trucks and SUVs, in rollover crashes (see p. 6).

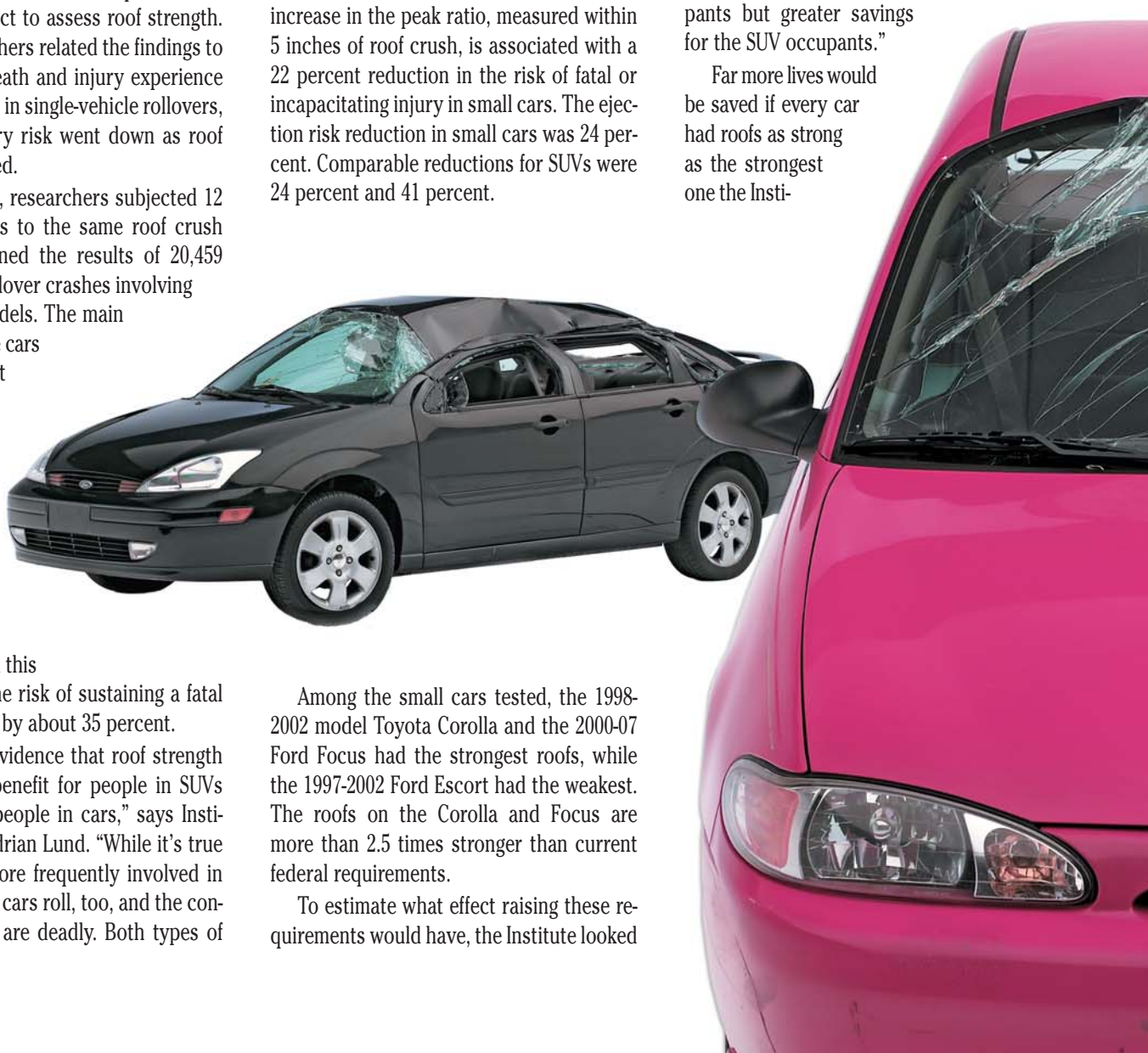
Because crush in a rollover can depend on vehicle weight as well as roof strength, Institute researchers calculated so-called strength-to-weight ratios for study vehicles. The researchers estimate that a 1-unit increase in the peak ratio, measured within 5 inches of roof crush, is associated with a 22 percent reduction in the risk of fatal or incapacitating injury in small cars. The ejection risk reduction in small cars was 24 percent. Comparable reductions for SUVs were 24 percent and 41 percent.

Among the small cars tested, the 1998-2002 model Toyota Corolla and the 2000-07 Ford Focus had the strongest roofs, while the 1997-2002 Ford Escort had the weakest. The roofs on the Corolla and Focus are more than 2.5 times stronger than current federal requirements.

To estimate what effect raising these requirements would have, the Institute looked at 2 hypothetical targets: a 2.5 strength-to-weight ratio, which is the level NHTSA proposes for a new safety standard, and a 3.9 strength-to-weight ratio representing the strongest roof among the study vehicles. Both targets were measured within 5 inches of roof crush, and researchers estimated that designing the roofs on every small car in the study to meet a minimum requirement of 2.5 would have prevented about 3 of the 228 deaths of drivers and right front passengers in these cars during 2007.

"Looking at the study vehicles, we noted that the car roofs tended to be stronger than the SUV roofs relative to their curb weights," Lund says. "So the minimum roof crush standard the government is proposing would result in only modest crash death declines for these car occupants but greater savings for the SUV occupants."

Far more lives would be saved if every car had roofs as strong as the strongest one the Insti-



tute tested. About 75 of the 228 front-seat occupant deaths in these cars during 2007 would have been prevented.

Researchers also examined whether stronger roofs make vehicles more prone to rolling over. This is a concern sometimes voiced by automakers who fear that vehicles will become top-heavy if they have stronger roofs. However, the Institute's analyses indicate that vehicles with stronger roofs aren't more likely to roll over. Single-vehicle rollovers as a proportion of all police-reported crashes were estimated to fall by 11 percent for a 1-unit increase in strength-to-weight ratio.

For a copy of "Roof strength and injury risk in rollover crashes of passenger cars and SUVs" by M.L. Brumbelow and E.R. Teoh, write: Publications, Insurance Institute for Highway Safety, 1005 N. Glebe Rd., Arlington, VA 22201, or email publications@iihs.org.

THE STRONGEST ROOFS REDUCED THE RISK OF FATAL OR SERIOUS INJURY IN SMALL CARS BY ABOUT 35 PERCENT. THE 2000-07 FORD FOCUS HAD ONE OF THE STRONGEST ROOFS, WHILE THE ONE ON THE 1997-2002 FORD ESCORT WAS WEAKEST.

WHY NHTSA'S ESTIMATE OF LIVES SAVED IS SO LOW

The National Highway Traffic Safety Administration (NHTSA) argues that upgrading the roof crush standard will have a limited effect on rollover deaths and serious injuries. The agency says fewer than 45 lives would be saved — just a fraction of the deaths in rollovers each year. This lowball estimate contrasts sharply with the Institute's research.

"The agency made too many unproven assumptions about the relationship between roof strength and injury risk," says Institute president Adrian Lund. "For example, if someone was ejected during a rollover, NHTSA ignored the possibility that this wouldn't have occurred if the roof had held up better. Based on this one flawed assumption, the agency eliminated more than a third of all deaths as potential beneficiaries of stronger roofs."

NHTSA assumed that stronger roofs wouldn't help people who died in vehicles that didn't roll beyond the first side, possibly because the roll was arrested by a tree or other object (14 percent of deaths), or in vehicles that were arrested later in the roll (12 percent). Nor would stronger roofs help occupants who were unbelted (15 percent), who weren't in front seats or were younger than 12 years old (3 percent), or if their most serious injuries weren't related to roof crush directly over their heads (12 percent).

"It's a long list," Lund points out. "When NHTSA got to the end of it, hardly anyone was left who met the narrow criteria. The agency discarded 94 percent of rollover deaths."

Instead of trying to figure out what would have helped people who died in rollover crashes, as NHTSA did, the Institute compared the outcomes of all people in rollovers, not just those who died, and didn't limit the study to those who were belted or weren't ejected. Comparing the injury rates in vehicles with varying roof strengths, the Institute researchers determined how many people stronger roofs already are helping. A main finding is that such roofs decrease the risk of being ejected.

"We'll know more as we continue to test new vehicles," Lund adds.

TOUGHER RULE ON ROOF CRUSH IS STILL NEEDED

Debate over upgrading the federal roof strength standard has been long and contentious. There's no dispute that thousands of people die each year in rollover crashes — more than 10,000 in 2007 alone. The disagreement among government, industry, and highway safety stakeholders lies in how best to solve the problem.

"If government rulemaking rested solely on science, there would have been an upgraded roof crush standard decades ago," says Institute president Adrian Lund. "Instead the process has been bogged down by politics and indecision."

Cars have been built to meet the same roof crush standard, Federal Motor Vehicle Safety Standard 216, since 1973. Originally adopted to address passenger vehicle crashworthiness in rollovers and covering cars only, the rule was extended in 1994 to include all passenger vehicles up to a gross weight rating of 6,000 pounds. Many SUVs and pickups were heavier, so they were exempt.

Safety advocates have pressed the National Highway Traffic Safety Administration (NHTSA) for years to extend the rule to the larger vehicles — plus improve protection for all passenger vehicle occupants in rollover crashes.

What the government has been doing: NHTSA didn't act until 2005, when it was directed by Congress to address this issue. The agency's notice of proposed rulemaking was issued in August 2005, followed in January 2008 by a proposal to crush vehicle roofs on both sides, driver and passenger. A final standard was due by July 1, 2008, but Mary Peters, US transportation secretary in the Bush Administration, said in June there would be a delay until October. Later she promised a new standard by mid-December and then postponed it again until April 30, 2009, leaving it to her successor, Ray LaHood, to sort out.

"Under new leadership, we hope the agency is devising a tougher standard to address what's really happening in rollover crashes," Lund says. "NHTSA's earlier proposals didn't go far enough, mainly because the agency underestimated the importance of roof strength."

During the Bush years, NHTSA chose to emphasize other ways to reduce deaths and injuries in rollovers. The agency argued that upgrading the roof crush standard would have only a limited impact. In its 2005 notice of proposed rulemaking, it estimated that the proposed rule would save 13 to 44 lives — a small fraction of the deaths that occur in rollovers each year. Manufacturers, too, have pushed for a weak standard.

"Automakers and regulators have been dancing around this issue for years, focusing on everything but strengthening roofs," Lund points out. "We agree with NHTSA that preventing rollovers in the first place is key to solving the problem, and crash avoidance features like electronic stability control certainly help. Convincing drivers to use safety belts and refrain

ROOFS ON CARS AND MOST PICKUPS AND SUVS WOULD BE STRONGER UNDER A NEW SAFETY STANDARD, BUT THE GOVERNMENT'S PROPOSAL DOESN'T GO FAR ENOUGH. MANY VEHICLES ALREADY MEET THE PROPOSED ROOF STRENGTH REQUIREMENTS, AND INSTITUTE RESEARCH SHOWS A TOUGHER STANDARD WOULD SAVE MORE LIVES.

from driving if they're impaired by alcohol are important, too, but these complementary measures are no substitute for making roofs stronger so people in rollovers remain in their vehicles and have more occupant compartment survival space."

Industry stance: The Alliance of Automobile Manufacturers contends that roof strength isn't related to injury risk in a crash, pointing to two automaker-funded studies to support its claim (see *Status Report*, March 15, 2008; on the web at iihs.org). The Institute's 2008 roof crush analysis proved those studies flawed.

The automaker group disputes the Institute's finding that roof strength and injury risk are related. Robert Strassburger, vice president of vehicle safety and harmonization for this group, told a Senate committee during a June 2008 hearing that the Institute's data "do not demonstrate a relationship between roof strength and injury causation in rollovers."

Steve Oesch, the Institute's senior vice president for insurer and government relations, countered at the hearing that the earlier studies' findings "defy logic" because "in every other crash configuration — whether front, side, or rear — the basic principles of occupant protection dictate that the compartment be designed to resist intrusion so lap/shoulder safety belts and airbags can provide protection to occupants. There is no logical reason to assume that in a rollover crash you would design a vehicle to permit excessive intrusion."

The auto trade group backed NHTSA's recommendation to extend roof strength requirements to heavier vehicles with gross weight ratings of 10,000 pounds or less and to use a strength-to-weight ratio of 2.5. However, this group rejected tougher measures, arguing that a ratio higher than 2.5 would heighten the weight mismatch between passenger vehicle classes and adversely affect fuel economy.

BASIC PRINCIPLES OF PROTECTING PEOPLE IN CRASHES REQUIRE THE OCCUPANT COMPARTMENT, INCLUDING THE ROOF, TO RESIST INTRUSION.

Lund notes that many vehicles already meet the 2.5 strength-to-weight ratio. The Institute's roof crush studies support a ratio of at least 4. This is the minimum a vehicle must achieve to earn a good rating in the Institute's new test.

A DYNAMIC TEST WOULD BE IDEAL, BUT WHICH ONE?

The government and the Institute evaluate the strength of vehicle roofs by pushing a metal plate into the roof of a stationary vehicle. Because crash test dummies aren't used, the static test can't directly provide key information about injury risk to occupants involved in real-world rollover crashes. Nor can this static test evaluate the effectiveness of restraint systems like safety belts, rollover curtain airbags, and padding in vehicle interiors.

A dynamic test could fill in the missing data. However, the best way to conduct such a test and how to evaluate the results are still under debate.

Real rollover crashes occur in lots of ways, and engineers have come up with different kinds of tests to address various aspects of these crashes — dolly rollovers, curb trips, dirt trips, corkscrews, and fallovers, among others. No single test best represents the broad spectrum of actual crashes.

Measuring how a roof crushes in a dynamic test is trickier than in a static test, and some testing methods would preclude having dummies inside the vehicles. The dummy itself is a problem because none of the existing types was designed to assess injury risk in a rollover crash. Some dummies may not even move like people do when turned upside down.

A further complication is that many rollovers are preceded by other events that may affect occupants' positions when their vehicles roll. This means researchers will have to figure out the best position for a dummy in a dynamic test.

In the end, specifying a dynamic test is a big task that's only just started. In the meantime, Institute research shows that making roofs stronger as measured in a relatively simple test will prevent many injuries and deaths in rollover crashes.

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Vol. 44, No. 3, March 24, 2009

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