



The small overlap test evaluates occupant protection in a frontal crash involving 25 percent of a car's front end. A good or acceptable rating is required to earn the new TOP SAFETY PICK+ award.

group of moderately priced midsize cars outperformed most of their luxury counterparts in a challenging new frontal crash test conducted by the Insurance Institute for Highway Safety (IIHS) on 2013 models. Of the 18 midsize family cars evaluated in the small overlap test, two earn the top rating of good, 11 earn acceptable, three earn marginal, and two are poor.

In contrast, just 3 of 11 midsize luxury and near-luxury cars evaluated in the inaugural round of small overlap tests earned good or acceptable ratings (see Status Report, Aug. 14, 2012, at iihs.org). Midsize moderately priced cars are the second group to be tested.

Building on its long-running vehicle ratings program for consumer information, IIHS introduced the small overlap test in 2012 to further improve occupant protection in frontal crashes. Most automakers design their vehicles for good performance in the IIHS moderate overlap frontal test and the federal government's fullwidth frontal test, but many haven't addressed the problem of small overlap crashes. In a 2009 IIHS study of vehicles with good ratings for frontal crash protection, small overlap crashes accounted for nearly a quarter of the frontal crashes involving serious or fatal injury to front seat occupants (see Status Report, March 7, 2009).

The small overlap test replicates what happens when the front corner of a car collides with another vehicle or an object like a tree or utility pole. In the test, 25 percent of a car's front end on the driver side strikes a 5-foot-tall rigid barrier at 40 mph. A 50th percentile male Hybrid III dummy is belted in the driver seat.

"It's remarkable that this group of midsize family cars did so much better than the midsize luxury car group," says Adrian Lund, IIHS president. "The difference is stunning. Thirteen of these midsize cars offer better crash protection than all but three of their luxury counterparts, and at a price that's easier on the wallet."

#### New safety award

To reward 2013 models with superior crash protection, IIHS has created the TOP SAFETY PICK+ award, with the + indicating good or acceptable performance in the new small overlap test. Winners must earn good ratings for occupant protection in at least 4 of 5 evaluations and no less than acceptable in the fifth test. IIHS rates vehicles good, acceptable, marginal or poor based on performance in a moderate overlap frontal crash, small overlap frontal crash, side impact and rollover test, plus evaluations of seat/head



the accolade. Winners include: the Dodge Avenger and its twin, the Chrysler 200 4-door; Ford Fusion; Honda Accord

2-door; Accord 4-door; Kia Optima; Nissan Altima 4-door; Subaru Legacy and its twin, the Outback; Suzuki Kizashi and Volkswagen Passat. Two previously tested luxury models, the Acura TL and Volvo S60, also earn TOP SAFETY PICK+. IIHS will announce additional winners as it continues to test models. Results for small SUVs are expected in the spring.

Meanwhile, 117 additional vehicles earn TOP SAFETY PICK for 2013 (see p. 5). To qualify, vehicles must have good ratings in the moderate overlap frontal test, side impact, rollover and rear tests, regardless of their small overlap rating. IIHS first gave TOP SAFETY PICK to 2006 models and has tightened criteria twice (see Status Report, March 24, 2009).

IIHS gives manufacturers advance notice of planned changes. Automakers in the past have been quick to factor new IIHS evaluations into their designs, and many are on track to do the same with the introduction of the small overlap test and TOP SAFETY PICK+.

"We've seen automakers make structural and restraint changes in response to our small overlap test," Lund says. "Five manufacturers redesigned their midsize cars to enhance small overlap crash protection."

Honda engineered both 2-door and 4-door versions of the Accord to do well in the test. Ford and Nissan

# **2013** IIHS TOP SAFETY PICK+



The TOP SAFETY PICK+ award goes to 2013 models that earn good or acceptable in the new small overlap test, in addition to good ratings in at least 4 of 5 evaluations and no less than acceptable in any test.

#### Midsize moderately priced cars

Chrysler 200 4-door Dodge Avenger Ford Fusion Honda Accord 2-door Honda Accord 4-door Kia Optima Nissan Altima 4-door Subaru Legacy Subaru Outback Suzuki Kizashi Volkswagen Passat

#### Midsize luxury cars

Acura TL Volvo S60

### Midsize cars' small overlap frontal ratings

				Dummy injury measures			
(	Overall	Structure	Restraints & kinematics	Head & neck	Chest	Hip & thigh	Lower leg & foot
Honda Accord	G	Α	G	G	G	G	G
Suzuki Kizashi	G	G	A	G	G	G	G
Ford Fusion	Α	A	A	G	G	G	G
Honda Accord	A	A	A	G	G	G	G
Kia Optima	A	M	G	G	G	G	G
Nissan Altima 4-door	A	A	G	G	G	G	P
Nissan Maxima	A	M	G	G	G	G	G
Subaru Legacy	A	M	G	G	G	G	G
Subaru Outback	A	M	G	G	G	G	G
Dodge Avenger	Α	Α	M	G	G	G	G
Chrysler 200	A	A	M	G	G	G	G
Mazda 6	A	A	M	G	G	G	G
Volkswagen Passat	Α	A	M	G	G	G	G
Hyundai Sonata	M	M	A	G	G	G	M
Chevrolet Malibu	M	M	M	G	G	G	M
Volkswagen Jetta sedan	M	M	M	G	G	G	P
Toyota Camry	P	P	P	G	G	G	A
Toyota Prius v	P	P	P	G	G	P	P
			Good G	Acceptable A	. Mar	ginal M	Poor P

The key to crash protection is a strong safety cage that preserves occupant survival space. Then restraint systems can cushion and protect people.



It's easy to see why the Suzuki Kizashi earns a good rating for structure. There was only minor intrusion into the occupant compartment. In contrast, survival space for the driver in the Toyota Prius v was seriously compromised. The side curtain airbag also deployed too late in the crash to offer any protection. made running structural changes to 2013 models already in production. Likewise, Subaru and Volkswagen changed airbag control modules on the production line so side curtain airbags would deploy for improved head protection.

#### Toyota falls short

Shoppers looking for a midprice family car will recognize some perennial bestsellers on the TOP SAFETY PICK+ list. including the Accord, Altima and Fusion.

One nameplate they won't find is Toyota. The Camry, which is the top-selling midsize car in the United States, and the Prius v, a 4-door hybrid wagon, earn poor ratings for small overlap protection and are the worst performers of the midsize group. The Camry was redesigned for 2012, and the Prius v was an all-new model for 2012.

The Camry and Prius v illustrate what can go wrong in a small overlap crash, despite good ratings in IIHS tests that qualify the cars for TOP SAFETY PICK.

Most modern cars have safety cages built to withstand head-on collisions and moderate overlap frontal crashes with little deformation, and the two Toyotas are no exception. Crush zones help manage crash energy to reduce forces on the occupant compartment. The main crush-zone structures are concentrated in the middle 50 percent of the front end. When a crash involves these structures, the occupant compartment is protected from intrusion, and front airbags and safety belts can effectively restrain and protect people inside.

For many vehicles, a 25 percent overlap frontal impact misses the primary structures designed to manage crash energy and results in crash forces going directly into the wheel, suspension system and firewall. Such crashes often have high levels of occupant compartment intrusion. It is not uncommon for the wheel to be forced rearward into the footwell. contributing to even more intrusion in the occupant compartment and resulting in serious leg and foot injuries. Since the impact occurs toward the car's outer edge, the vehicle has a tendency to rotate during the collision, resulting in the driver's head moving outboard, away from the frontal airbag. Real crashes of this

type result in head injuries from contact with outboard structures or intruding objects such as trees or poles.

In the Camry, the force of the impact shoved the front wheel back into the footwell, bending the windshield pillar and pushing the parking brake pedal and the left outer edge of the instrument panel rearward into the driver's survival space. Likewise, there was significant intrusion in the Prius v, along with high forces on the dummy's legs and feet. The Prius v is the only car in the midsize test group to earn a poor rating for hip and thigh protection.

The Camry's driver airbag and side curtain airbag deployed, but the steering wheel moved so far to the right that the dummy's head made only minimal contact with the front airbag. The side curtain airbag didn't extend far enough forward to help prevent the dummy's head from hitting the instrument panel. In the Prius v, the side curtain airbag deployed too late in the crash to offer protection.

"Toyota engineers have a lot of work to do to match the performance of their competitors," Lund says.

#### Demanding crash

The small overlap frontal test represents a severe crash. When cars strike the test barrier they tend to move sideways away from it, and the interior structures including the driver door, side window and windshield pillar move in the same direction. The dummy, however, continues forward into the path of the sideways-moving interior structures. At the same time, the steering column and driver airbag move inboard in many vehicles as the front end and occupant compartment deform. If the dummy misses the airbag or slides off it, its head and chest are unprotected.

Front airbags are calibrated to deploy in these crashes. Side airbags, especially head-protecting curtains, don't always deploy because they are designed mainly for direct side impacts. When they do deploy, they don't always do so early enough or extend far enough forward to adequately protect people.

Without airbags, people in small overlap frontal crashes can sustain head injuries from direct contact with the windshield pillar, dashboard or window sill or by hitting trees, poles or other objects. Chest injuries happen when people contact the steering wheel, door or other intruding structures.

The Accord sedan shows how safety belts and airbags work together to provide exemplary protection. The dummy stayed engaged with the Accord's front airbag, and the steering wheel remained relatively stable because there was only moderate intrusion into the occupant compartment. That meant that the driver airbag was in the right position to cushion the dummy's head and chest. The side curtain airbag extended far enough forward to prevent the dummy's head from hitting interior components.

Every midsize car evaluated earns good ratings for head, neck and chest injury risk based on measurements from dummy sensors. Similar real-world crashes, however, often result in serious upper body injuries.

"The dummy doesn't always tell us everything," Lund says. "The crash damage in these tests is like the damage we see in real-world crashes where heads and chests are injured."

#### **Unexpected outcomes**

In the Jetta test, engineers at the Vehicle Research Center witnessed a first for IIHS crash testing when the driver airbag module detached from the steering column. It happened relatively late in the crash and didn't affect the dummy's movement. Still, airbags should stay in place in crashes, so engineers had to lower the restraints and kinematics score for the marginal-rated Jetta. IIHS isn't aware of a problem with Volkswagen's airbag module in real-world crashes, and Volkswagen is investigating further.

The Kizashi's results also are unique. The car, which Suzuki introduced in the 2010 model year, is the only midsize moderately priced car to earn a good rating for structure in the small overlap test. The Kizashi also earns good ratings in the moderate overlap frontal test, side test and seat/ head restraint evaluation. Its roof strength rating, however, is acceptable, so it has never qualified for TOP SAFETY PICK.

"The Kizashi is a rare case. Its good small overlap test performance outweighs its acceptable rollover rating, so the car is a TOP SAFETY PICK+. So far this is the only model we have evaluated to be in this situation," Lund explains. Suzuki Motor Corp. in November said it would stop selling cars in the United States.

## **2013** IIHS TOP SAFETY PICK

#### **Minicars**

Fiat 500 Ford Fiesta Honda Fit Nissan Versa sedan Toyota Yaris 4-door

#### Small cars

Acura ILX Chevrolet Cruze, Sonic, Volt Dodge Dart Ford Focus Honda Civic 4-door Honda CR-Z, Insight Hvundai Elantra Kia Forte sedan Kia Soul Lexus CT 200h Mazda 3 Mini Cooper Countryman Mitsubishi Lancer except Ralliart and Evolution models Nissan Cube, Juke Scion FR-S, tC, xD Subaru BRZ, Impreza, XV Crosstrek Toyota Corolla, Prius, Prius c Volkswagen Golf only 4-door models Volkswagen GTI only 4-door models

#### Midsize moderately priced cars

Audi A3 Buick Verano Chevrolet Malibu Hyundai Sonata Toyota Camry, Prius v Volkswagen Jetta sedan Volkswagen Jetta SportWagen Volvo C30

#### Midsize luxury/ near luxury cars

Acura TSX Audi A4 sedan BMW 3 Series only sedans Lexus ES Mercedes C-Class Volkswagen CC except 4-wheel drive V6

#### Large family cars

Buick LaCrosse, Regal Chrysler 300 Dodge Charger Ford Taurus Hyundai Azera Toyota Avalon

#### Large luxury cars

Audi A6 BMW 5 Series except 4-wheel drive and V8 Cadillac CTS only sedans Cadillac XTS Hyundai Equus, Genesis Lexus GS Lincoln MKS Mercedes E-Class 2-door Mercedes E-Class 4-door Volvo S80

#### Small SUVs

Ford Escape Honda CR-V Hyundai Tucson Jeep Patriot with optional side torso airbags Kia Sportage Mazda CX-5 Mitsubishi Outlander Sport Subaru Forester Volkswagen Tiguan

#### Midsize SUVs

Chevrolet Equinox Dodge Durango, Journey Ford Edge, Explorer, Flex **GMC** Terrain Honda Crosstour, Pilot Hyundai Santa Fe Jeep Grand Cherokee Kia Sorento Subaru Tribeca Toyota 4Runner, Highlander, Venza

#### Midsize luxury SUVs

Acura MDX, RDX Audi Q5 BMW X3 Cadillac SRX Infiniti EX Lexus RX Lincoln MKT, MKX Mercedes GLK, M-Class Volvo XC60, XC90

#### Large SUVs

**Buick Enclave** Chevrolet Traverse **GMC** Acadia Volkswagen Touareg

#### Minivans

Chrysler Town & Country Dodge Grand Caravan Honda Odvssev Toyota Sienna Volkswagen Routan

#### Large pickups

Ford F-150 crew cab models Honda Ridgeline Toyota Tundra crew cab models



TOP SAFETY PICK recognizes vehicles that do the best job of protecting people in moderate overlap frontal, side, rollover and rear crashes based on good ratings in IIHS evaluations.

### **Volvo owners give thumbs-up** to crash avoidance features

wners of Volvos with advanced crash avoidance features find the systems useful, and the vast majority would want the technology again, an IIHS survey shows. The positive results are in line with an earlier survey (see Status Report, Nov. 18, 2009, at iihs. org). This time, the participants were not limited to the early adopters questioned several years ago, when the technology was new.

Researchers interviewed nearly 500 owners of Volvo models with crash avoidance features. Some had City Safety, a low-speed forward collision avoidance system standard on certain models; some had an optional technology package that includes forward collision warning, lane departure warning and other features; and some had both.

"The majority of these drivers told us they like the crash avoidance technology in their vehicles," says Anne McCartt, senior vice president for research at IIHS. "For the most part they are taking advantage of the systems, and many credit them with preventing crashes."

Based on insurance data, these systems appear to be reducing crashes. The Highway Loss Data Institute (HLDI) has found that the rate of property damage liability claims for Volvos with standard City Safety is lower than for other vehicles in the same class and for Volvos without the technology (see Status Report, July 19, 2011). HLDI also found lower claim frequencies with the optional technology package, which includes a higher-speed forward collision warning system with autonomous braking, adaptive cruise control, distance alert, lane departure warning and fatigue warning (see Status Report, July 3, 2012).

Drivers' reactions are important because many systems provide only warnings and require drivers to take action. And most features can be deactivated, so the technologies need to be accepted to be effective.

Among the respondents with the optional technology package, about half said they always used adaptive cruise control, which maintains a set following distance, on high-speed roads. Eighty-nine percent said that when adaptive cruise control is not in use they always drive with distance alert, which warns the driver if the vehicle is getting too close to one in front but, unlike adaptive cruise control, doesn't affect vehicle speed. The same number said they leave forward collision warning on at all times, while fewer than two-thirds always drive with lane departure warning. Of the respondents with City Safety, 78 percent always drive with the system on. Eighteen percent said they weren't aware they had City Safety. It is likely those people also were driving with the system activated, since the default is "on."

The lower use rate for lane departure warning may be related to the annoyance factor: One-third of respondents said they found the feature's warning chime annoying. Drifting slightly over a lane marking is a common occurrence, and some drivers are accustomed to exiting, merging or changing lanes without signaling, which would trigger the warning. The system also can be triggered by things like old lane markings in construction zones.

The earlier IIHS survey, which involved owners of Volvo and Infiniti vehicles with crash avoidance features, also found that fewer drivers kept lane departure warning on at all times than other features. In that survey, a quarter of Volvo owners and 41 percent of Infiniti owners found lane departure warning annoying. The tendency to turn off the system seems to have grown: Among the first group, 69 percent of Volvo owners said they always drove with lane departure warning, compared with 59 percent in the new survey.

In the current study, most owners reported experiencing activations of lane departure warning, forward collision warning and fatigue warning. Thirty-seven percent said they experienced autonomous braking, including City Safety. Many respondents said they believed the features had helped prevent crashes. For example, 45 percent of those who had driven with forward collision warning said the alerts from that feature had helped them avoid a crash.

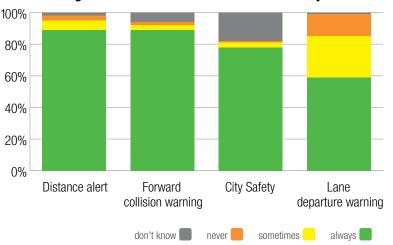


lane departure warning. Unnecessary autonomous braking wasn't as commonly reported at 14 percent.

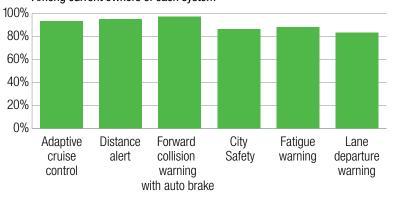
For each feature, more than 80 percent of respondents said they would want the system again on their next vehicle.

While the responses are similar to the earlier survey, this update shows positive reactions weren't limited to drivers who eagerly snapped up a brand new safety technology. The first survey involved Volvos from 2008, the first model year that both forward collision warning and lane departure warning were offered as options. The current study involves 2010-12 Volvos and is the first to look at City Safety, which, because it comes standard, could be more likely to include respondents whose attitude toward safety is similar to the average driver.

#### Percentage of owners who drive with crash avoidance systems on



#### Percentage of owners who want system on next vehicle Among current owners of each system



"While lane departure warning lags behind other technologies in the percentage of drivers who use it all the time, all these features are proving to be popular with a majority of drivers," McCartt says. "That bodes well for the future of crash avoidance. With more driver interest, more manufacturers should understand that it pays to invest in these systems and will offer them in more vehicles."

For a copy of "Volvo drivers' experiences with advanced crash avoidance and related technologies" by A.H. Eichelberger and A.T. McCartt, email publications@iihs.org.

## **Combination side airbags** reduce death and injury risk

ide airbags that protect the head and torso reduce the likelihood of death and upper body injuries to passenger vehicle drivers in near-side crashes by 61 percent compared with no side airbags. This is the main finding of a new study by the Monash University Accident Research Centre.

The Victoria, Australia, study reinforces prior research on the effectiveness of side airbags that protect people's heads and torsos in crashes. A 2006 study by the Insurance Institute for Highway Safety (IIHS) found that side airbags with head protection reduce a car driver's risk of death in a near-side crash by an estimated 37 percent and an SUV driver's risk by 52 percent (see Status Report, Oct. 7, 2006, at iihs.org).

Monash University researchers matched police reports of 2001-09 driver-side crashes in Victoria, Australia, with insurance injury claims data to look specifically at injuries to body regions directly relevant to side airbags.

The researchers found a 51 percent reduction in the odds of death and injury to all body regions and a 53 percent reduction in death and injury risk to the head, neck and face in vehicles equipped with headand-torso-protecting side airbags. In comparison, researchers found that side airbags designed to protect only a person's torso didn't provide any statistically significant injury reductions. This finding differs from research by IIHS showing that torso-only side airbags reduce fatality risk by 26 percent for car drivers and 30 percent for SUV drivers.

Under the Australasian New Car Assessment Program (ANCAP), vehicles must have head-protecting side airbags for the driver and front passenger in order to earn the maximum 5-star safety rating. Starting in 2014, second-row seats must have side airbags, too.

The U.S. government doesn't mandate side airbags specifically but does require a high level of head and torso protection for all occupants in side crashes. In IIHS crash tests assessing protection in a side impact, all of the vehicles that perform well are equipped with head-protecting side airbags.

For a copy of "Evaluation of vehicle side airbag system effectiveness" by A. D'Elia et al. go to www.monash.edu.au/miri/research/ reports/muarc312.html



#### **Shopping for a Safer Car brochure** helps buyers home in on best choices

Selecting a safer vehicle is a lot easier than it used to be. Most new cars, minivans, pickup trucks and SUVs earn good ratings in front and side crash tests. Some models still need improvement when it comes to protecting people in rollovers and rear crashes. This IIHS publication explains the features safety-conscious consumers should consider. Go to iihs.org/brochures for a digital copy. For print brochures, email publications@iihs.org.

## **Status Report**

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