

Status Report

Insurance Institute for Highway Safety | Highway Loss Data Institute

Rating models for **front** crash prevention



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IIHS issues first crash avoidance ratings under new test program; 7 midsize vehicles earn top marks for front crash prevention

A new test program by the Institute rates the performance of front crash prevention systems to help consumers decide which features to consider and encourage automakers to speed adoption of the technology. The rating system is based on research by the Highway Loss Data Institute (HLDI) indicating that forward collision warning and automatic braking systems are helping drivers avoid front-to-rear crashes.

The Institute rates models with optional or standard front crash prevention systems as superior, advanced or basic depending on whether they offer autonomous braking, or autobrake, and, if so, how effective it is in tests at 12 and 25 mph. Vehicles rated superior have autobrake and can avoid a crash or substantially reduce speeds in both tests. For an advanced rating a vehicle must have autobrake and avoid a crash or reduce speeds by at least 5 mph in 1 of 2 tests.

To earn a basic rating, a vehicle must have a forward collision warning system that meets National Highway Traffic Safety

Administration performance criteria. For a NHTSA endorsement, a system must issue a warning before a specified time in 5 of 7 test trials under three scenarios. The agency identifies vehicles with compliant systems at safercar.gov/Safety+Ratings.

Moderately priced and luxury midsize cars and SUVs are the first to be evaluated in the new IIHS test program. These include 74 2013-14 models. Seven earn the highest rating of superior when equipped with optional autobrake and forward collision warning systems. They are the Cadillac ATS sedan and SRX SUV, Mercedes-Benz C-Class sedan, Subaru Legacy sedan and Outback wagon, Volvo S60 sedan and XC60 SUV.

Six models earn an advanced rating when equipped with autobrake and forward collision warning. These include the 2014 Acura MDX SUV, Audi A4 sedan and Q5 SUV, 2014 Jeep Grand Cherokee SUV, Lexus ES sedan and the 2014 Mazda 6 sedan. In addition, the Volvo S60 and XC60 earn an advanced rating when they aren't equipped with an option called Collision Warning

with Full Auto Brake and Pedestrian Detection. The S60 and XC60 are the only models in the new test program with standard autobrake. Called City Safety, the system brakes to avoid a front-to-rear crash in certain low-speed conditions without warning the driver before it takes action.

Twenty-five other vehicles earn a basic rating. Three models that are available with a forward collision warning system earn higher ratings when they are equipped with autobrake. They are the 2014 Acura MDX and two Cadillacs, the ATS and SRX. Thirty-six midsize models either don't offer a front crash prevention system at all, or they have a system that doesn't meet NHTSA or IIHS criteria.

"Front crash prevention systems can add a thousand dollars or more to the cost of a new car. Our new ratings let consumers know which systems offer the most promise for the extra expense," says David Zuby, IIHS chief research officer.

The front crash prevention ratings complement the Institute's long-standing crash

Front crash prevention ratings

2013-14 midsize cars and SUVs

		12 mph test		25 mph test		autobrake	Forward
		speed reduction	points	speed reduction	points	total points	collision warning
SUPERIOR 							
	Subaru Legacy (EyeSight)	12 mph	2	25 mph	3	5	1
	Subaru Outback (EyeSight)	12 mph	2	25 mph	3	5	1
	Cadillac ATS (Forward Collision Alert, Automatic Collision Preparation)	12 mph	2	15 mph	2	4	1
	Cadillac SRX (Forward Collision Alert, Automatic Collision Preparation)	12 mph	2	19 mph	2	4	1
	Mercedes-Benz C-Class (Distronic Plus and Pre-Safe Brake)	11 mph	2	13 mph	2	4	1
	Volvo S60 (City Safety/Collision Warning with Full Auto Brake and Pedestrian Detection)	12 mph	2	14 mph	2	4	1
	Volvo XC60 (City Safety/Collision Warning with Full Auto Brake and Pedestrian Detection)	12 mph	2	11 mph	2	4	1
ADVANCED 							
	Acura MDX (2014; Forward Collision Warning/Collision Mitigation Brake System)	7 mph	1	6 mph	1	2	1
	Audi A4 (Audi pre sense front)	11 mph	2	0 mph	0	2	1
	Audi Q5 (Audi pre sense front)	11 mph	2	0 mph	0	2	1
	Jeep Grand Cherokee (2014; Forward Collision Warning with Crash Mitigation)	4 mph	0	7 mph	1	1	1
	Lexus ES (Pre-Collision System)	6 mph	1	4 mph	0	1	1
	Mazda 6 (2014; Smart City Brake Support)	12 mph	2	0 mph	0	2	0
	Volvo S60 (City Safety)	12 mph	2	2 mph	0	2	0
	Volvo XC60 (City Safety)	12 mph	2	1 mph	0	2	0
BASIC 							
	Acura MDX (2014)** Acura ZDX BMW 3 series, X3 Cadillac ATS, SRX** Chevrolet Equinox, Malibu Dodge Durango (2014)*	Ford Edge, Explorer, Flex, Fusion GMC Terrain Honda Accord, Crosstour Infiniti EX, FX, JX* Infiniti Q50, QX50, QX60, QX70 (2014)*		Jeep Cherokee (2014)* Lexus IS and RX (2014)* Lincoln MKT, MKX, MKZ Mercedes-Benz GLK, M-Class*			

Point system based on autobrake performance

speed reduction (mph)	points
12 mph test	
less than 5	0
5 to 9	1
10 or more	2
25 mph test	
less than 5	0
5 to 9	1
10 to 21	2
22 or more	3

SUPERIOR

Models earning a total of 5 to 6 points, based on performance in autobrake tests and credit for forward collision warning.

ADVANCED

Models earning a total of 2 to 4 points, based on performance in autobrake tests and credit for forward collision warning.

BASIC

Models earning 1 point for forward collision warning or in 1 of 2 autobrake tests.

 For details on individual vehicles, go to iihs.org

*Note: These models have an autobrake system that IIHS hasn't tested, with the exception of the Infiniti JX. In the test of the JX, renamed the QX60 for 2014, the autobrake system didn't earn enough points to qualify for a higher rating.

** Note: These models have an optional forward collision warning system without autobrake.



Running into an actual car puts the test driver at risk and is expensive, so IIHS uses a stationary target as a stand-in. Under the vinyl cover, inflatable tubes and foam sit on a metal frame, which is then affixed to metal guides on the track to keep the target from moving until it is struck by the test vehicle. A GPS system and other sensors monitor the test vehicle's lane position, speed, time to collision, braking and other data. An on-board camera captures each test run from the driver's perspective and monitors any warnings issued by the front crash prevention system.

test program telling consumers how well passenger vehicles protect people in a range of crash configurations. In its crashworthiness program, the Institute rates vehicles good, acceptable, marginal or poor based on performance in moderate overlap front, small overlap front, side, roof strength and head restraint evaluations.

For crash avoidance technologies, the Institute developed a three-tier rating system of superior, advanced and basic to reflect that even a basic forward collision warning system can provide significant benefits.

About the technology

Front crash prevention is part of a larger group of crash avoidance features spreading through the U.S. vehicle fleet. Marketed under various trade names, system capabilities vary by manufacturer and model, and most are offered as optional add-ons. In general, current front crash prevention systems fall into two categories: forward collision warning and front crash mitigation or prevention with autobrake.

Forward collision warning alerts a driver when the system detects that the vehicle is about to crash into another vehicle in front, but the system doesn't slow down or stop the vehicle. Some forward collision warning systems are combined with an autobrake system to reduce vehicle speeds in

a crash, but they aren't designed to avoid the collision. Acura's Collision Mitigation Brake System is an example.

Other autobrake systems can slow down or completely stop the car to avoid some front-to-rear crashes if its driver doesn't brake or steer out of the way in response to a warning. Like the Acura system, these will reduce the speed of those crashes they can't prevent. Cadillac's Automatic Collision Preparation and Volvo's Collision Warning with Full Auto Brake and Pedestrian Detection combined with City Safety are examples.

Another design difference involves whether the vehicle ahead is stopped or moving. All of the front crash prevention systems that earn a superior or advanced rating from IIHS are capable of braking for a stopped or slower-moving vehicle. Some other systems are designed to brake for a stopped car ahead only if sensors first detect the car moving before it stops. The 2013 BMW 3 series sedan is available with this type of system. It gets a basic rating for front crash prevention.

"The point of autobrake systems is to help inattentive drivers avoid rear-ending another car," Zuby explains. "It's clear that the ability to automatically brake for both stopped and moving vehicles prevents the most crashes."

Test track evaluations

To gauge how autobrake systems from different manufacturers perform, the Institute conducted a series of five test runs at speeds of 12 and 25 mph on the track at the Vehicle Research Center in Ruckersville, Va. In each test, an engineer drove the vehicle toward a stationary target designed to simulate the back of a car. Sensors in the test vehicle monitored its lane position, speed, time to collision, braking and other data. The IIHS protocol is similar to the procedure the European New Car Assessment Programme uses to evaluate autobrake systems, which the group plans to begin rating in 2014.

The Institute awards as many as five points in the autobrake tests, based on how much the systems slow the vehicle to avoid hitting the inflatable target or lessen the severity of the impact. In the case of an unavoidable collision, lowering the striking vehicle's speed reduces the crash energy that vehicle structures and restraint systems have to manage. That reduces the amount of damage to both the striking and struck car and minimizes injuries to people traveling in them.

"We decided on 25 mph because development testing indicated that results at this speed were indicative of results at higher speeds — and because higher-speed tests would risk damaging the test vehicles," Zuby says. "As such, we expect crash mitigation benefits at higher speeds as well."

In addition to points in the autobrake tests, vehicles earn one point if they have a forward collision warning system that meets NHTSA criteria. That means vehicles can earn a maximum of six points total for front crash prevention. Models with one point earn a basic rating. A total of 2 to 4 points qualifies vehicles for an advanced rating, and 5 to 6 points qualifies vehicles for a superior rating.

The highest-scoring cars and SUVs have autobrake and substantially reduce speeds in both the 12 and 25 mph tests. Most of these systems prevent the 12 mph collision.

Subaru's EyeSight performed best. It helped the Legacy and Outback avoid hitting the target at both test speeds. Next best was Cadillac's Automatic Collision Preparation. The system helped the ATS and SRX avoid hitting the target in the 12 mph test and reduced the ATS's speed by 15 mph and the SRX's speed by 19 mph in the 25 mph test.

"We want to help get the most effective systems in as many vehicles as soon



12 mph test: Mercedes-Benz C-Class into rear of Chevrolet Malibu



25 mph test: Mercedes-Benz C-Class into rear of Chevrolet Malibu



Crash tests show how autobrake can mitigate crash severity, damage costs

The idea of an autobrake system is to prevent a front-to-rear impact or reduce speeds to mitigate the crash. To show why reducing speed is important, IIHS conducted two demonstration crash tests at different speeds. In each test, a 2013 Mercedes-Benz C-Class ran into the back of a stationary 2012 Chevrolet Malibu. The tests illustrate what happens in a 25 mph crash when the striking vehicle doesn't have autobrake, compared with what happens when autobrake reduces the speed by 13 mph. This is how much the C-Class's autobrake system reduced the car's speed in IIHS track testing. Total damage in the higher speed crash test was about \$28,000. The Malibu was a complete loss. Lowering the speed to 12 mph trimmed the damage to \$5,700. Since these were relatively low-speed tests, it's no surprise that dummies in both vehicles indicated low injury risk and airbags didn't deploy. A similar speed reduction in a higher speed crash would significantly reduce injury risk, as well as vehicle damage.

Damage estimates for Mercedes C-Class into Chevrolet Malibu

Speed	Mercedes C-Class	Chevrolet Malibu	Total
12 mph	\$3,438	\$2,277	\$5,715
25 mph	\$9,457	\$18,674	\$28,131

as possible. That means a speed mitigation system like Subaru's EyeSight that can prevent crashes at low and moderate speeds," Zuby says. "At the same time, we want consumers to know that forward collision warning alone can help them avoid crashes, and it's a feature that's available on more models than autobrake."

Besides the 2013 BMW 3 series, another midsize model advertised with autobrake also earns a basic rating. In tests of the Infiniti JX SUV, there was only minimal braking at 12 and 25 mph. The Toyota Prius v wagon, which claims to have autobrake, had minimal braking in IIHS tests and currently fails to meet NHTSA criteria for forward collision warning. It doesn't qualify for an IIHS front crash prevention rating.

Real-world crashes basis for ratings

The ratings program is based on HLDI research of the insurance claims of Acura, Mercedes-Benz and Volvo models with front crash prevention systems (see *Status Report*, July 3, 2012, at iihs.org). Property

damage liability claim frequencies for Acura and Mercedes models were 14 percent lower when equipped with forward collision warning with autobrake than when they weren't. Claims were 7 percent lower for vehicles with forward collision warning only. Property damage liability is the insurance that pays for damage to vehicles struck by an at-fault driver. Volvo's autobrake system (an earlier version called Forward Collision Warning with Auto Brake) also reduced the claim rate 10 percent, but that finding wasn't statistically significant. The analysis also found that the systems lower claims under bodily injury liability insurance.

Additional HLDI analyses of City Safety, Volvo's standard low-speed collision avoidance system, found that claims under property damage liability were filed 16 percent less often for S60 sedans than other midsize luxury cars. For XC60s, claims under the same coverage were filed 15 percent less often than for other midsize luxury SUVs (see *Status Report*, April 25, 2013).

"Real-world data tell us these systems are preventing crashes," Zuby says. "We plan to

make front crash prevention a requirement to earn *TOP SAFETY PICK+*. For 2014, models will need at least a basic rating to qualify for the award."

New criteria for highest safety accolade

The Institute introduced the *TOP SAFETY PICK+* award last year to recognize models with the best crash protection. To qualify for the 2014 award, vehicles must earn a basic, advanced or superior rating for front crash prevention. This is in addition to a good or acceptable rating for occupant protection in a small overlap front crash, plus good ratings in the moderate overlap front, side, roof strength and head restraint tests.

To qualify for a 2014 *TOP SAFETY PICK* award, models must earn a good or acceptable rating for occupant protection in the small overlap front test, plus good ratings in the moderate overlap front, side, roof strength and head restraint tests.

Winners of the 2014 awards will be announced in December. ■

ESC, strong roofs reduce but don't cut all rollover injuries

The odds of dying in a rollover crash have fallen in recent years, thanks to safety improvements such as electronic stability control (ESC), side curtain airbags and stronger roofs. As more and more vehicles on the road are equipped with these features, rollover crashes and deaths can be expected to fall even further.

As important as these three features are, they won't make rollover injuries and deaths disappear entirely. To help determine the next steps in improving rollover crashworthiness, IIHS researchers have been analyzing rollovers of vehicles that had some or all of these features.

"As the number of rollover crashes that result in injuries decreases, the characteristics of the remaining ones are changing," says IIHS senior research engineer Matthew Brumbelow. "If we want to cut rollover deaths and injuries even further, we need to look at how these remaining crashes are different."

Vehicles roll in just 2 percent of crashes, but these crashes account for more than a third of passenger vehicle occupant deaths. In recent years, fatal rollovers have been rapidly decreasing (see *Status Report*, June 9, 2011, at iihs.org). The rate of rollover driver deaths per million registered vehicles 1-3 years old has fallen from 27 in 2000 to 8 in 2011, much faster than the rate of other crash deaths. Some of the recent decline reflects the economic downturn, but key reasons for the rollover drop in particular are more stable SUV designs and the increasing prevalence of ESC, which prevents the sideways skidding that can lead to rollovers. ESC has been required on all new passenger vehicles since the 2012 model year.

Meanwhile, airbags and strong roofs have increased the odds of surviving a rollover. In many vehicles, head-protecting side airbags are linked to rollover sensors, causing them to deploy when the vehicle flips, even if there isn't an initial side impact. These help prevent occupants from being ejected and protect them from contact with the ground or vehicle interior. Stronger roofs also prevent ejection and injury in a rollover, as occupant space is better maintained (see *Status Report*, April 26, 2011, and March 24, 2009).

To find out what kind of rollovers remain, the Institute turned to a federal database containing a sample of crashes and looked for rollovers that occurred from 2003 through 2011. Researchers looked for rollovers of at least two quarter turns involving vehicles



Vehicles roll over in just 2 percent of crashes, but these crashes account for more than a third of passenger vehicle occupant deaths.

with good IIHS roof-strength ratings and found 61 cases to examine. For a good rating, a vehicle's roof must resist a force of 4 times the vehicle's weight before reaching 5 inches of crush.

Since the database doesn't indicate whether a specific vehicle has ESC if it was optional on that model, researchers compared vehicles known to have standard ESC with ones that had no ESC or had it only as an option. In nearly all of the 19 crashes of models with standard ESC, the rollovers were preceded by an impact. In other words, they were pushed over by another vehicle or they flipped after hitting an object. In contrast, 37 percent of the rollovers of vehicles without standard ESC weren't preceded by an impact, meaning in all likelihood they lost stability during a maneuver.

"Rollovers of vehicles with ESC tend to be more complex crashes," Brumbelow says. "If the rollover is preceded by an impact, then the side airbags may have already deployed by the time the vehicle flips. Safety belts may have more slack, and the occupants may be out of position. That makes it a little more complicated to ensure there is good protection during the roll."

There always have been rollovers caused by an initial impact, but since it is more difficult for ESC to address them, they will account for a larger proportion of the remaining rollovers as ESC becomes more common. Although they are more complex, rollovers of vehicles with ESC tend to be less severe. Only 9 percent of the crashes of models with standard ESC involved six or more quarter turns. In contrast, 41 percent of the rollovers of vehicles without standard ESC did.

The rate of serious injury in rollovers of vehicles with good IIHS roof-strength ratings was 5 percent. Vehicles without good ratings, which weren't part of the main analysis, were found in a separate calculation to have a 14 percent injury rate.

Among the strong-roof group, there were no serious injuries in any of the 14 vehicles that had ESC and in which both side curtain airbags deployed.

"In this small sample of crashes, the combination of ESC, side curtain airbags and good roof strength seemed to work well to prevent rollover injuries," Brumbelow says. "We'll continue to study the issue as data on more crashes become available, but it's already apparent the effects of these technologies need to be taken into account when developing countermeasures for the remaining rollover problem. For example, rollover crash tests should be developed to represent the complexity of these crashes."

"Rollovers of the future: strong roofs, ESC and curtain airbags," a presentation by M. Brumbelow, is available at iihs.org/iihs/topics/presentations. ■

Subaru, Volvo dealers report sales boost from good crash test ratings

Consumers are paying attention to results of the Institute's newest crash test, and two brands that did well in it have reaped higher sales, dealer surveys show.

To gauge the impact in the marketplace of the small overlap front crash test program launched last year, IIHS researchers surveyed 206 Volvo dealerships following the August 2012 release of the first small overlap test results. The Volvo S60 was one of only two midsize luxury or near-luxury cars to earn good ratings in the first round of testing. A second survey involving 275 Subaru and 275 Jeep dealers was conducted after results for small SUVs were announced in May. The Subaru Forester earned a good rating for small overlap front crash protection, while the Jeep Patriot was rated poor and the Jeep Wrangler was marginal (see *Status Report*, Aug. 14, 2012, and May 30, 2013, at iihs.org).

Interest in the S60 and the Forester increased in the weeks after the good ratings were announced, dealers reported. In the case of the S60, 49 percent of Volvo dealers reported stronger interest. Seventy-five percent of Subaru dealers said the same about the Forester.

Dealers reported a 41 percent increase in S60 sales and an 18 percent uptick in sales of all Volvo models in the week after IIHS announced the results, compared with the week prior to the release. Sales of the Forester, meanwhile, increased 14 percent, and sales of all Subaru models rose 11 percent, dealers reported. In contrast, Jeep dealers reported that sales were essentially flat, with a slight decrease of 2 percent for the Patriot.

"Safety sells," says IIHS President Adrian Lund. "In this respect, the small overlap test is no different from other tests we've introduced over the years. Our ratings have prompted automakers to make improvements because they know consumers are paying attention."

In a 2010 poll, 86 percent of licensed drivers surveyed said safety is a very important consideration when buying a vehicle (see *Status Report*, April 15, 2010).

In the IIHS surveys of dealers, good test results for a particular model seemed to have a halo effect for the entire brand. More than half the Volvo dealers said consumers were more likely to mention the brand's safety credentials after the announcement. Sixty-one percent of Subaru dealers said at least a quarter of their customers since the middle of May had mentioned the recent crash test performance as a reason they were considering buying a Subaru.

For a copy of "Survey of Volvo dealers about effects of small overlap frontal crash test results on business" and "Effects of small overlap frontal crash test results on vehicle sales: more evidence with small SUVs," both by J.B. Cicchino, email publications@iihs.org. ■



Subaru saw stronger interest in the Forester after the small SUV earned a good rating for small overlap front crash protection from IIHS.

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The **Insurance Institute for Highway Safety** is an independent, nonprofit scientific and educational organization dedicated to reducing the losses — deaths, injuries and property damage — from crashes on the nation's roads.

The **Highway Loss Data Institute** shares and supports this mission through scientific studies of insurance data representing the human and economic losses resulting from the ownership and operation of different types of vehicles and by publishing insurance loss results by vehicle make and model.

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