April 2019

Automotive Technology Update

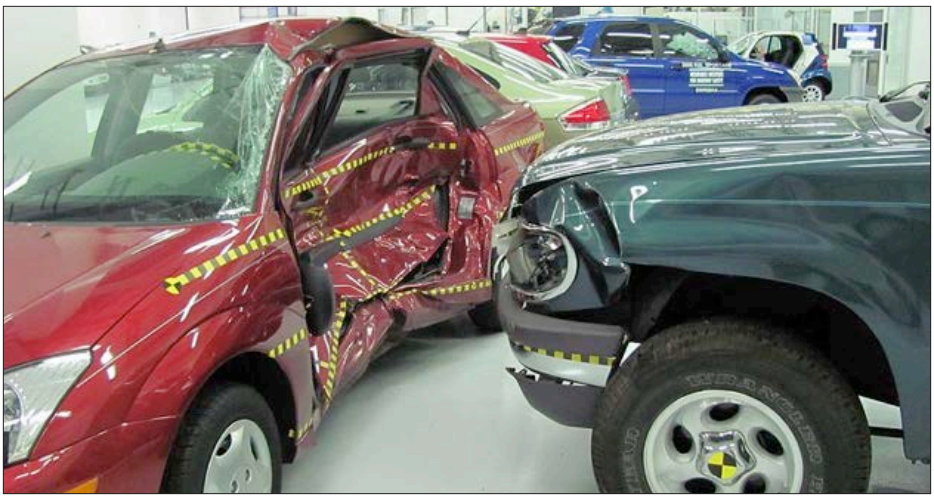
Vehicle Safety Ratings

Need to Know

- Vehicle safety is a major consideration in many car-buying decisions.
- NHTSA and IIHS safety ratings are excellent indicators of new and used vehicle safety.
- NHTSA and IIHS ratings are primarily based on occupant protection in a variety of crash types.
- IIHS ratings also take into account the performance of headlights, seats and head restraints, and front crash avoidance and mitigation systems.
- NHTSA and IIHS both test and/or recommend additional safety systems that are not currently factored into their safety ratings.

Introduction

Automobile safety is a matter of life and death. According to the National Highway Traffic Safety Administration (NHTSA), more than 37,000 people died in vehicle crashes in 2017.[1] In addition, the Centers for Disease Control and Prevention (CDC) say vehicle collisions send more than 2.3 million individuals to hospital emergency rooms each year.[2] No one wants to become part of those statistics.



The outcome of a side impact crash test. (Image: Brady Holt, CC BY 3.0)

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What is an ATU?

AAA Automotive Technology Updates (ATUs) provide expert information on a variety of topics related to modern vehicles. Some feature in-depth answers to common questions about automobile use and maintenance. Others explore new technologies in today's rapidly evolving automobiles. For additional information, visit www.AAA.com/autorepair.

Despite these troubling numbers, modern automobiles are actually much safer than older models. Vehicle improvements to help prevent collisions or mitigate their consequences have been continually introduced over the years. Since 1975, the trend in traffic fatalities measured in deaths per 100 million vehicle miles travelled (VMT) has been consistently downward, although there have been some years in which fatalities increased compared to the prior 12 months.

Automobile safety enhancements have been partially driven by government regulations, but playing an even bigger role have been vehicle safety rating programs that allow consumers to assess the safety of individual car models. Today there are two such programs in the U.S. NHTSA operates a New Car Assessment Program (NCAP) that awards 5-Star Safety Ratings, and the Insurance Institute for Highway Safety (IIHS) operates a program that awards Top Safety Pick ratings.

There are a number of other vehicle safety rating programs outside the U.S., including the Australian New Car Assessment Program (ANCAP), European New Car Assessment Programme (Euro NCAP) and the Japanese New Car Assessment Programme (JNCAP). Although the ratings of other NCAPs are based on tests similar to those done by NHTSA and IIHS, the results are not directly comparable due to variations in both testing protocols and local vehicle safety regulations.

Automakers take vehicle safety rating programs very seriously and work hard to design new cars that achieve good scores. Most tests in the NHTSA and IIHS programs have been updated over time, and new tests have also been added periodically to cover additional crash scenarios and take into account newer technologies. Today, safety ratings have reached such a high degree of public awareness that their requirements are driving vehicle changes even without additional government regulations.

NHTSA operates a New Car Assessment Program (NCAP) that awards 5-Star Safety Ratings, and the Insurance Institute for Highway Safety (IIHS) operates a program that awards Top Safety Pick ratings.

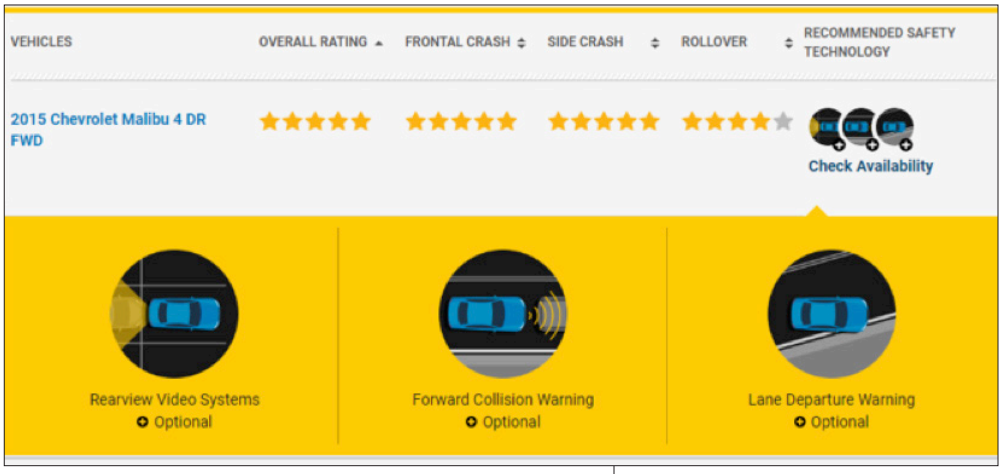
NHTSA – 5-Star Safety Ratings

The National Highway Traffic Safety Administration (NHTSA) was established in 1970 and tasked with reducing vehicle crash fatalities/injuries and their related economic costs. Results of the first crash tests, using dummies to simulate vehicle occupants, were released in 1978 and dealt with frontal crashes only. In 1996, a side barrier crash test was added, and in 2000 a measure of vehicle rollover resistance became part of the assessments.

The 5-Star Safety Ratings system was introduced in 1993 to help consumers make better-informed car-buying decisions. In 2004, NHTSA launched the **www.safercar.gov** website for easy "one-stop" consumer access to 5-Star Safety Ratings (as far back as 1990 for some vehicles) and other highway safety information. Since 2006, vehicle manufacturers have been required to include 5-Star Safety Ratings information on the new vehicle window sticker, also called the Monroney label.

In 2010, the 5-Star Safety Rating program was upgraded with an additional side pole crash test and the use of improved crash test dummies to gather more and better injury information. NHTSA also introduced a single "Overall Vehicle Score" for each model based on the weighted average of its frontal crash, side crash, and rollover scores. Finally, although not part of the ratings, NHTSA began highlighting the value of certain crash avoidance systems.

In 2015, NHTSA announced plans for a significant update of the 5-Star Safety Ratings program. It sought comments from stakeholders, and meetings were held as recently as September, 2018, to gather additional input. While the exact nature of the final changes is uncertain, they are expected to include an additional crash test, incentives for automakers to install advanced safety systems, and a greater emphasis on educating consumers and providing them with vehicle safety information.



NHTSA 5-Star Safety Ratings and crash avoidance system availability for a 2015 Chevrolet Malibu. (Image: NHTSA)

Safety Ratings

The tests used to establish NHSTA 5-Star Safety Ratings are scored as follows:

- 5 Stars = Crash injury risk for this vehicle is much less than average
- 4 Stars = Crash injury risk for this vehicle is less than average to average
- 3 Stars = Crash injury risk for this vehicle is average to greater than average
- 2 Stars = Crash injury risk for this vehicle is greater than average
- 1 Star = Crash injury risk for this vehicle is much greater than average

Some ratings also include an alert symbol in the form of a triangle containing an exclamation point. This symbol indicates that a special safety concern was noted during testing. The nature of the concern can vary, but common examples include a structural failure, fuel leakage or a door that fails to remain securely latched throughout the test. Special safety concerns are not factored into the ratings, and even a 5-star vehicle may have a safety concern.

A five-star overall safety rating with a special safety concern notation. (Image: NHTSA)

Each year, NHTSA tests a sampling of new vehicles that are expected to sell in large numbers or have undergone significant structural redesigns. To ensure untainted results, test cars are purchased randomly from dealers across the country; they are not supplied by automakers.

Due to budget and time constraints, NHTSA cannot test every car on the market. Many low-volume luxury and exotic vehicles are never tested, but that doesn't mean they are unsafe. All vehicles sold in the U.S. have to meet extensive Federal Motor Vehicle Safety Standards (FMVSS) established by the Department of Transportation (DOT). Part of this process involves crash testing to ensure compliance with FMVSS related to side impact protection, fuel system integrity and electric vehicle battery electrolyte spillage and shock protection.

For testing purposes, passenger cars are put into five categories based on their curb weight with all fluids, including a full tank of gas. Vans, sport utility vehicles and pickup trucks have their own categories. Due to the 2010 program revisions, test results from before the 2011 model year cannot be compared to those that came after. In fact, some cars that were rated highly in earlier tests might rate lower in the current tougher tests, but there is no way to know for sure. NHTSA does not retest cars to update its older ratings, although they remain available for reference on **www.safercar.gov**.

Within the pre- and post-2011 groups, side crash and rollover ratings can be compared across all vehicle categories. However, frontal crash ratings are only comparable between vehicles in the same category whose weights are within 250 pounds of one another. Rear crash protection has never been tested by NHTSA, primarily because frontal and side impacts, along with rollovers, are responsible for the vast majority of collision-related injuries and fatalities.

The sections that follow provide additional information on the tests used to establish the current NHTSA 5-Star Safety Ratings.

Frontal Crash Test

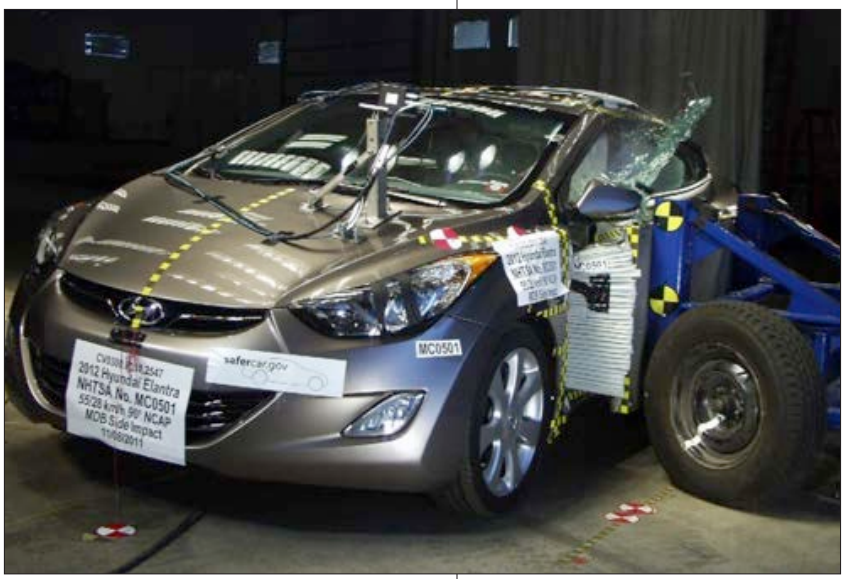
The frontal crash test simulates a head-on collision between two vehicles of the same weight that are travelling in opposite directions, both at 35 mph. The test is conducted by crashing the subject vehicle into a fixed barrier at 35 mph, which provides an equivalent impact. A video of a frontal crash test can be viewed at **https://bit.ly/2O1RMWE**.

An Audi undergoing a frontal crash test. (Image: NHTSA)

Crash test dummies the size of an average adult male and a small adult female are placed in the driver and front passenger seats, respectively, and secured with seat belts. During the collision, sensors in the dummies measure impact forces to the head, neck, chest and legs of the driver and passenger. The frontal crash rating is based on an evaluation of the data and the projected severity of injuries to the vehicle occupants.

Side Barrier Crash Test

The side barrier crash test simulates a "T-bone" collision in which the front of another car impacts the driver's door of the subject vehicle. The test is conducted by crashing a 3,015 lb. barrier moving at 38.5 mph into a stationary subject vehicle. Because the subject vehicle would typically be moving in a real-world collision of this type, it is angled in relation to the barrier to capture more representative impact data. Also, the moving barrier is covered with a crushable material that replicates the impact-absorbing traits of the front of a vehicle. A video of a side barrier crash test can be viewed at **https://bit.ly/2T7YdIK**.



A Hyundai Elantra side barrier crash test. (Image: NHTSA)

Crash test dummies the size of an average adult male and a small adult female are placed in the driver and rear passenger (driver-side) seats, respectively, and secured with seat belts. During the collision, sensors in the dummies measure impact forces to the head, chest, abdomen and pelvis of the driver and passenger. The side barrier crash rating is based on an evaluation of the data and the projected severity of injuries to the vehicle occupants.

Side Pole Crash Test

The side pole crash test simulates losing control of a car and sliding into a utility pole or tree. The test is conducted by pulling the subject vehicle sideways at 20 mph and a 75-degree angle into a rigid, small-diameter (254-cm / 10-inch) pole that impacts the driver's seating position. A video of a side pole crash test can be viewed at **https://bit.ly/2q8qcff**.

A SID-IIs crash test dummy, representing a small (5th percentile) adult female, is placed in the driver's seat and secured with a seat belt. NHTSA chose this smaller dummy for the side pole crash test because women and children are more likely than men to suffer head injuries in side impact crashes. During the collision, sensors in the dummy measure impact forces to the head, chest, lower spine, abdomen and pelvis of the driver. The side pole crash rating is based on an evaluation of the data and the projected severity of injuries to the vehicle occupant.

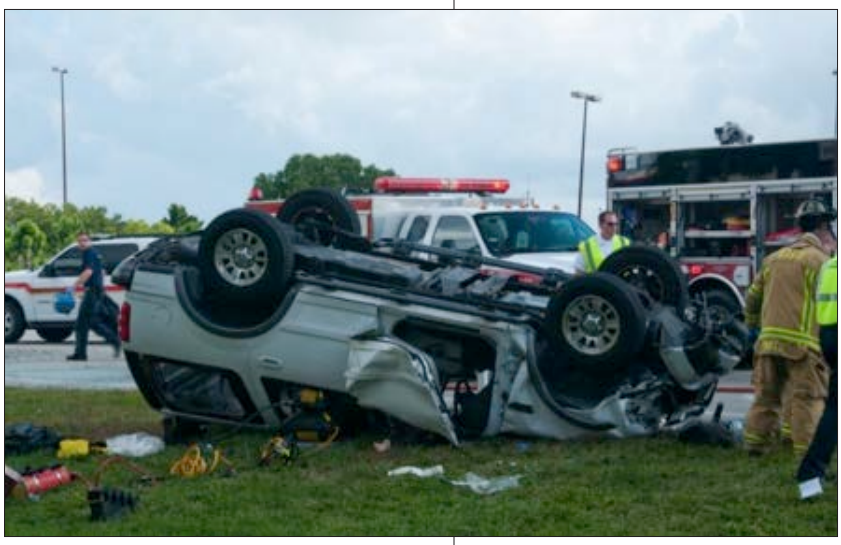
Combined Side Crash Rating

The side barrier and side pole tests described above are conducted and scored independently by NHTSA. However, for purposes of the 5-Star Safety Ratings the results are weighted and combined into a single side crash rating as shown in the chart on page 3.

Rollover Resistance Testing

Vehicle rollovers are particularly dangerous and result in roughly 25 percent of all crash fatalities. In 2000, NHTSA became the first U.S. organization to rate rollover resistance. The tests were updated for 2003 to better reflect real-world events. Rollover resistance testing simulates entering a curve too fast and losing control, after which the vehicle leaves the road and rolls over.

NHTSA's rollover resistance rating is based on two factors. First is a laboratory measurement to determine the vehicle's Static Stability Factor (SSF), an indicator of how "top-heavy" a vehicle is. Second is an on-road driving test that evaluates a vehicle's vulnerability to tipping during severe steering maneuvers. A video of a rollover resistance test can be viewed at **https://bit.ly/2CjWf2g**.



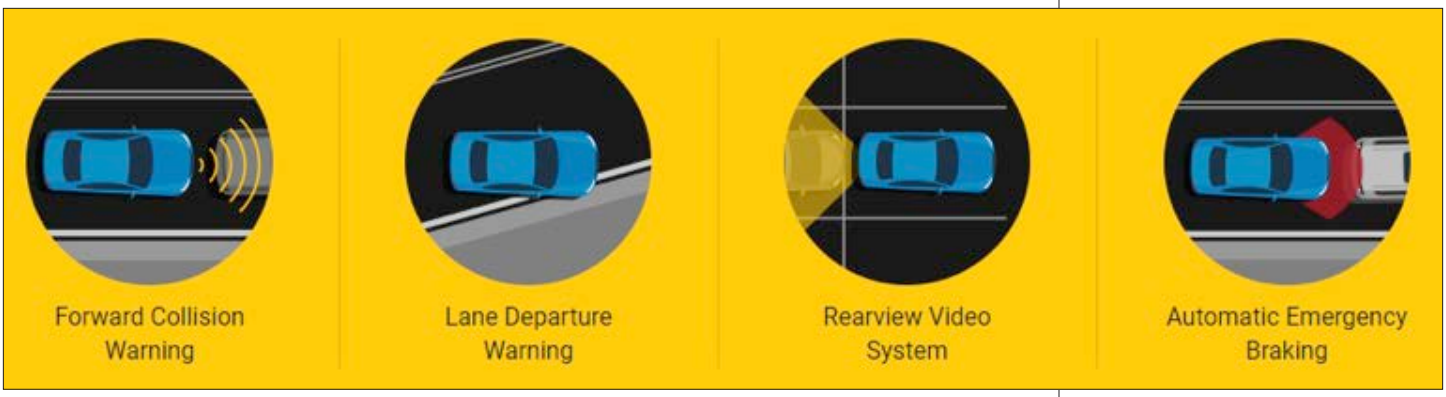
Vehicle rollovers cause a significant number of crash fatalities. (Image: Timothy Wildey, CC BY-NC 2.0)

Recommended Safety Technology

Although they are not factored into the 5-Star Safety Ratings, NHTSA has recommended several safety-related driver assistance technologies over the years. As part of the upgrades that took place in 2010, the 5-Star Safety Ratings began to note whether a vehicle was available with electronic stability control (ESC), lane departure warning (LDW) and/or forward collision warning (FCW) systems.

By the 2012 model year, federal law had made ESC standard equipment on all vehicles with a gross vehicle weight rating of 10,000 pounds or less. In response, the 5-Star Safety Ratings discontinued the ESC recommendation in 2013 and added rearview video systems in its place. In 2016, automatic emergency braking (AEB) was also added as a recommendation for 2018 and later vehicles, and automakers have committed to making the system standard on virtually all passenger cars by 2022.

As part of the upcoming changes to the 5-Star Safety Ratings it is likely rearview video systems will be removed as a recommendation because federal regulations have made these systems standard as of the 2018 model year. Other systems that may be added to the recommended list include blind spot warning, lane keeping assistance and automatic emergency braking for pedestrians. Experts also speculate that the availability of driver assistance technologies will become a factor in calculating the revised 5-Star Safety Ratings.



The four NHTSA recommended driver assistance technologies as of early 2019. (Image: NHTSA)

Other Vehicle Safety Offerings

In addition to its 5-Star Safety Ratings and recommended safety technologies, NHTSA continues to emphasize the importance of other safety-related systems that are standard on all new cars. These include airbags, seat belts and Tire Pressure Monitoring Systems (TPMS).

NHTSA also provides a tool to check whether there are any safety-related recalls that have not yet been performed on a given vehicle. This is done by entering the 17-character vehicle identification number (VIN) at **https://www.nhtsa.gov/recalls**. Consumers can also sign up at **http://www-odi.nhtsa.dot.gov/subscriptions/** to receive e-mail notifications when recalls are issued for their vehicles. Finally, a "Safercar" app that provides recall alerts and several other valuable features is available for both Apple and Android devices.

IIHS – Top Safety Pick Ratings

The Insurance Institute for Highway Safety (IIHS) was founded in 1959 by three insurance companies that made up around 80 percent of the market at the time. The Institute initially supported the highway safety efforts of others, but after 10 years was restructured as an independent research organization. IIHS deals with all aspects of highway safety, including human factors and the roadway environment. However, this paper focuses on their vehicle crashworthiness and collision avoidance work, which was bolstered in 1992 with the opening of a dedicated Vehicle Research Center (VRC).

IIHS has been highly proactive in developing vehicle crash tests and safety system evaluations that replicate real-world situations and form the basis of their Top Safety Pick rating system. The work of IIHS has also been instrumental in motivating automakers to build vehicles that provide increased occupant protection and better crash avoidance capabilities.

Top Safety Pick Ratings

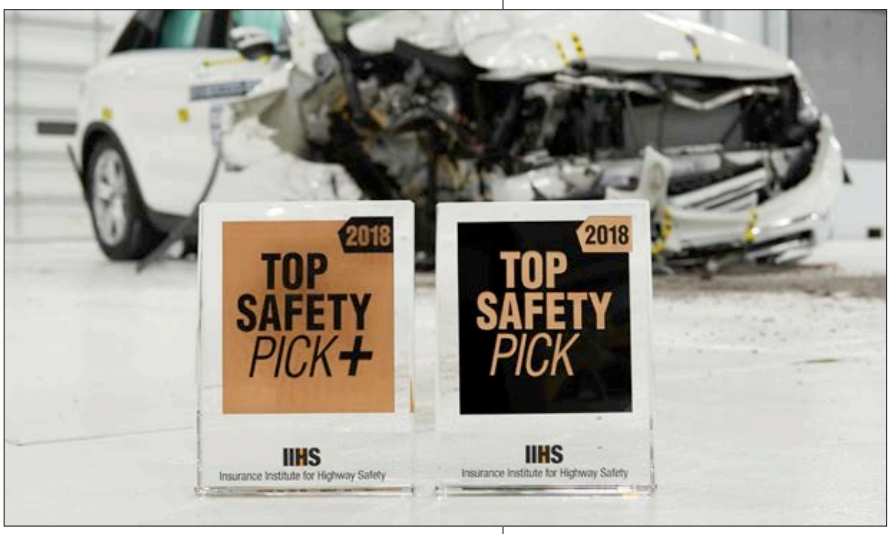
While similar in concept to NHTSA's 5-Star Safety Ratings, the IIHS Top Safety Pick ratings differ in several significant ways.

First, the IIHS ratings involve six (as opposed to NHTSA's four) tests of vehicle crashworthiness: driver-side small overlap front, passenger-side small overlap front, moderate overlap front, side, roof strength and seat/head restraints. For each test a vehicle is rated good, acceptable, marginal or poor.

Second, the IIHS ratings take into account vehicle crash avoidance and mitigation capabilities based on the availability and performance of forward collision warning (FCW) and automatic emergency braking (AEB) systems. For each test a vehicle is rated superior, advanced or basic.

Finally, the IIHS ratings include an assessment of headlight performance. Depending on the test results, a vehicle is rated good, acceptable, marginal or poor.

Based on the findings of the tests above, IIHS awards two levels of vehicle ratings, Top Safety Pick and Top Safety Pick+. The criteria for each award are as follows:



IIHS awards two levels of its Top Safety Pick rating. (Image: IIHS)

- Top Safety Pick
  - *Good* ratings in the driver-side small overlap front, moderate overlap front, side, roof strength and seat/head restraint tests
  - A *superior* or *advanced* rating for front crash prevention
  - A *good* or *acceptable* headlight rating
- Top Safety Pick+
  - Same as Top Safety Pick plus …
  - A *good* or *acceptable* rating in the passenger-side small overlap front test (added)
  - A *good* (not *acceptable*) headlight rating (upgraded)

There are no limits on the number of vehicles that can receive either award. Any car or truck that meets the applicable performance requirements qualifies. The sections that follow provide additional information on the individual tests used to establish the current IIHS Top Safety Pick ratings.

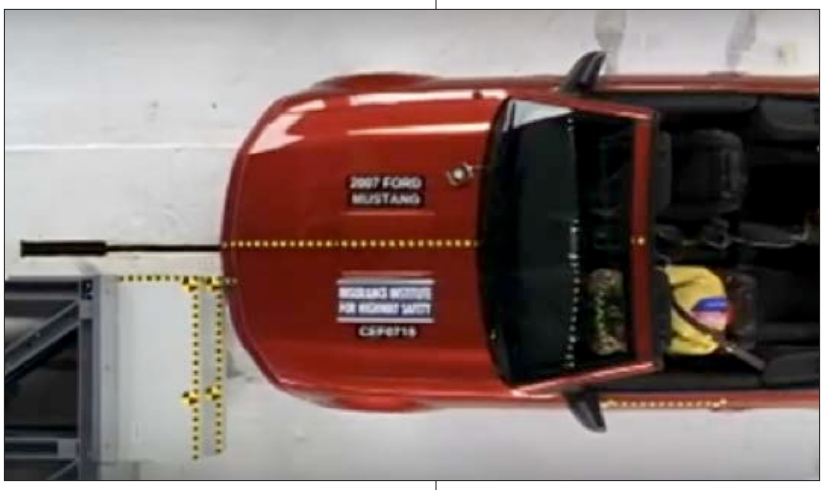
Frontal Crash Tests

Frontal crashes are the most common types of collisions that results in fatalities. Modern vehicles have a strong central body structure that forms a "safety cage" around the passenger compartment and protects occupants by resisting deformation in a collision. At the same time, the vehicle structures ahead of and behind the passenger compartment are designed with crush zones that absorb collision impacts in a controlled manner to reduce the impact forces transferred to vehicle occupants.

To assess a vehicle's crashworthiness in frontal crashes, the IIHS performs three tests: driver-side moderate overlap, driver-side small overlap and passenger-side small overlap. As with NHTSA's ratings, IIHS frontal crash test results can only be compared between vehicles in the same type category with near identical weights.

Driver-Side Moderate Overlap Test

This test complements NHTSA's frontal impact test, but the area of contact is offset from the vehicle centerline to better replicate the types of crashes that occur in the real world. While the NHTSA test puts greater loads on the seat belts and airbags, the IIHS test puts greater loads on the vehicle structure. Together, the two tests provide a more complete assessment of frontal crash protection.



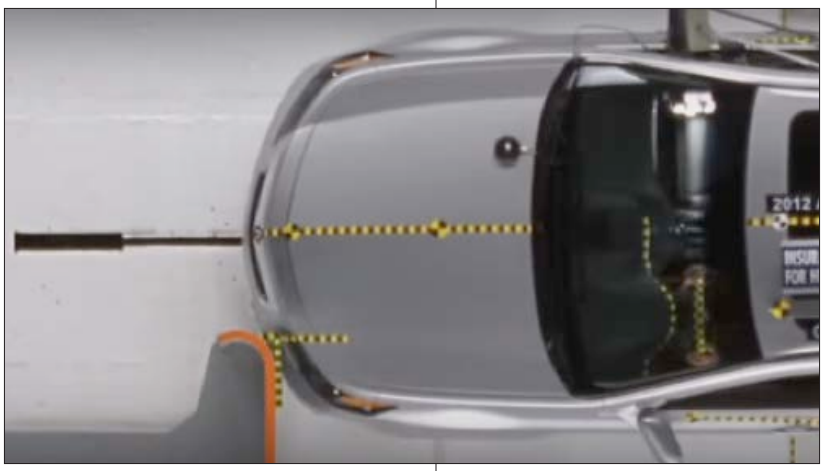
IIHS driver-side moderate overlap test. (Image: IIHS)

The IIHS driver-side moderate overlap test simulates what happens when the front left side of a car collides with another vehicle or an object like a tree or utility pole. The test is conducted by crashing a vehicle moving at 40 mph into a two-foot-tall barrier that has a deformable aluminum honeycomb face that simulates the front of another car. Forty percent of the vehicle's width impacts the barrier. A video of a driver-side moderate overlap test can be viewed at **https://bit.ly/2O5FQTU**.

A Hybrid III crash test dummy, representing an average-size adult male, is placed in the driver's seat and secured with a seat belt. The driver-side moderate overlap crash rating is based on the vehicle's post-crash structural integrity, the projected severity of injuries to the driver and the performance of the restraint systems in limiting driver movement during the crash.

Driver-Side Small Overlap Test

Initially, front crush-zones were concentrated at the center of the vehicle. Unfortunately, this provided less protection when the car experienced a crash at the outer edges of its front end. When this happened, collision forces were often transferred through the front wheel, suspension and firewall to the passenger compartment where they resulted in foot and leg injuries. IIHS instituted the driver-side small-overlap frontal crash test in 2012 to evaluate driver protection in these situations. The result has been vehicles with wider front crush zones and enhanced safety cage designs that better prevent intrusions into the footwells of the car.



IIHS driver-side small overlap test. (Image: IIHS)

The driver-side small overlap test simulates what happens when the front left corner of the vehicle collides with another car or an obstacle such as a tree or utility pole. This test is challenging for some seat belt and airbag designs because vehicle occupants move both forward and toward the side of the car at the time of impact. A video of an IIHS driver-side small overlap crash test can be viewed at **https://bit.ly/2JcLGEg**.

The test is conducted by crashing a vehicle moving at 40 mph into a five-foot-tall rigid barrier. Twenty five percent of the vehicle's width impacts the barrier. A Hybrid III crash test dummy, representing an average-size adult male, is placed in the driver's seat and secured with a seat belt. The driver-side small overlap crash rating is based on the same criteria as the driver-side moderate overlap test.

When the driver-side small overlap test debuted, many vehicles were given demerits because their side-curtain airbags did not provide sufficient forward coverage. Automakers responded by improving airbag designs, and as of the 2018 model year this concern has been virtually eliminated. Today, all new vehicles must meet federal motor vehicle safety standard (FMVSS) 226, which deals with passenger retention and protection in vehicle rollovers, and has led to the adoption of side airbags that provide a significantly larger coverage area.

Passenger-Side Small Overlap Test

Following the introduction of the driver-side small overlap test, automakers began updating their vehicle designs to achieve better test scores. However, changes made to the driver side of the car were not always applied to the passenger side as well. As a result, IIHS introduced a passenger-side small overlap crash test in 2017. This test is essentially the same as the driver-side test, except that the right front corner of the vehicle contacts the barrier, and two Hybrid III crash test dummies are used (representing average-size adult males), one in the driver's seat and one in the front passenger's seat.

Side Crash Test

Side crashes cause around one quarter of vehicle occupant deaths in the U.S. Providing side crash protection is difficult because there is much less area to absorb crash energy compared to the front and rear of a vehicle, which normally have sufficient space to incorporate crush zones. Automakers have addressed this problem by reinforcing the passenger compartment "safety cage" and using high-strength guard beams inside the doors. Most cars now also come with side airbags that help prevent occupants from contacting surfaces both inside and outside the car, and distribute the impact force over a larger portion of their bodies.

IIHS began performing side crash tests in 2003. In developing their test, the institute decided that the side crash test barrier created by NHTSA in the 1980s did not adequately represent more recent real-world crashes where vehicles are often struck by taller pickups and SUVs. To address this, IIHS elected to use a barrier with the height and shape of a typical pickup or SUV for its side crash test, allowing more accurate measurement of the potential for head injuries.

A side crash test comparison – the NHTSA barrier is shown in yellow while the taller IIHS barrier at the rear is gray.
(Image: IIHS)

The test is conducted by crashing a 3,300-pound barrier into the driver's side of the vehicle at 31 mph. A video of a side crash test can be viewed at **https://bit.ly/2Hyb2tN**. A pair of SID-IIs crash test dummies, representing a small (5th percentile) female or 12-year-old child, are positioned in the driver and rear passenger (driver side) seats, and secured with seat belts. IIHS chose this smaller dummy because women and children are more likely than men to suffer head injuries in side impact crashes.

The final side impact crash rating is based on the post-crash structural integrity of the vehicle, the projected severity of injuries to the vehicle occupants and the level of head protection provided. Based on a decade of side crash test data on cars with side airbags, IIHS says the driver of a vehicle rated good is 70 percent less likely to die than the driver of a vehicle rated poor. A driver of a vehicle rated acceptable is 64 percent less likely to perish, and a driver of a vehicle rated marginal is 49 percent less likely to not survive the crash.

As with the NHTSA side crash tests, the IIHS side crash test results can be compared across all vehicle type and weight categories. This is possible because the amount of kinetic energy delivered by the moving barrier is the same in every test.

Roof Strength Test

Thousands of people are killed annually in vehicle rollovers. Wearing a seat belt remains the first line of defense, but electronic stability control (standard on cars since 2012) has done a lot to help reduce rollovers – especially single-vehicle crashes. When rollovers do occur, the increased fitment of side airbags, and particularly the enhanced airbag designs used for compliance with FMVSS 226, have also helped save lives.

However, the available occupant protection measures may not make much difference if a vehicle roof can be easily crushed in a crash. The IIHS roof strength test measures the ability of car roofs to resist collapse when placed under pressure. The test is performed by forcing an angled metal plate down on one side of the roof at a constant slow speed, and measuring the maximum (peak) amount of force applied while crushing the roof a distance of five inches. A video of a roof strength test can be viewed at **https://bit.ly/2O5oMxo**.

The final rating in this test is based on the peak strength-to-weight ratio, which is pounds of pressure applied to the roof compared to the weight of the vehicle. For example, if a car weighs 4,000 pounds and the peak pressure measured when compressing its roof five inches is 16,000 pounds, the vehicle has a 4:1 strength-to-weight ratio. This is the minimum value required to earn a good rating, while an acceptable rating requires a 3.25:1 ratio and a marginal rating calls for a 2.5:1 ratio. Anything below that results in a poor rating.

An IIHS roof strength demonstration showing what happens when 15,000 pounds of force are applied to a 2008 Kia Sportage rated poor and a 2009 VW Tiguan rated good. (Images: IIHS)

Seat/Head Restraint Test

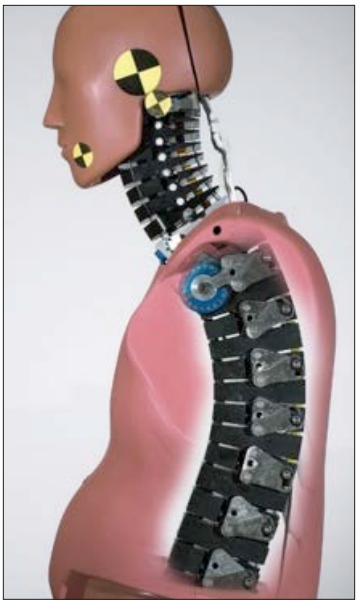
Neck sprains and strains, often called “whiplash,” are the most common types of injuries reported to car insurance companies. While such injuries can occur in any crash, they are most common when a vehicle is rear ended and its occupants’ heads snap backward. Well-designed seats with properly positioned head restraints can significantly reduce such injuries.

For maximum protection, a head restraint should be positioned at least as high as the head’s center of gravity (usually around 3.5 inches below the top of the head) and as close to the back of the head as possible and comfortable. Restraints that are positioned more than about 4 inches from the back of the head have been associated with increased symptoms of neck injuries in crashes.

The IIHS seat/head restraint test involves mounting the vehicle seat on a sled with the seatback reclined at a nominal 25-degree angle. A special crash test dummy that approximates the average size male and has highly sophisticated back and neck sensors is belted into the seat, and the head restraint is then adjusted as closely as possible to the optimum position. Finally, the sled is rapidly accelerated at a rate that simulates a stationary car being struck from behind by another vehicle of similar size and weight traveling 20 mph. A video of a seat/head restraint test can be viewed at **https://bit.ly/2Fctjv2**.

The overall rating in this test is based on a number of assessments. The first is a geometric measure of how closely the head restraint can be adjusted to the position that will provide maximum protection against whiplash. Since 2010, federal head restraint regulations have resulted in nearly all designs receiving an IIHS good rating, with the others being acceptable. The second part of the overall rating is a series of dynamic measurements that quantify how well the seat and head restraint support the torso, neck and head of the test dummy during the impact.

It should be noted that many vehicles are offered with a variety of seating options. For any given car, IIHS tests the seat design it thinks is most likely to be fitted to the majority of vehicles on dealer lots.



A BioRID 50th percentile male crash test dummy designed for rear-impact testing. (Image: IIHS)

Front Crash Avoidance and Mitigation

IIHS began rating cars for front crash avoidance and prevention in 2013 after research by their sister organization, the Highway Loss Data Institute (HLDI), found crash prevention systems help drivers avoid running into vehicles that are slowing or stopped in front of them. The IIHS ratings are based on whether a vehicle offers forward collision warning (FCW) or automatic emergency braking (AEB – which typically includes FCW), and how well the systems perform in track tests.

IIHS front crash avoidance and prevention ratings are based on a point system as shown in the accompanying illustration. Models with 1 point get a basic rating, two to four points results in an advanced rating, and five or six points earns a superior rating.

Cars equipped with only a FCW system that meets NHTSA requirements (it issues a warning within a certain time in five of seven trials under three scenarios) earn 1 point and a basic rating. NHTSA identifies FCW systems that meet its standard online, although the agency does not currently use this information as part of its own 5-Star Ratings system.

	12 mph test			25 mph test				Forward collision warning
Speed reduction (mph)	less than 5	5 to 9	10 or more	less than 5	5 to 9	10 to 21	22 or more	n/a
Points	0	1	2	0	1	2	3	1

IIHS front crash prevention ratings are based on points for FCW and AEB performance. (Image: IIHS)

Cars that also have an AEB system earn additional points based on how well the system performs in two track tests where the car is driven at 12 and 25 mph straight toward a stationary inflatable target that mimics the back of a car. To earn an advanced rating, the AEB system must avoid a crash or reduce vehicle speed by at least 5 mph in *one* of two track tests. For a superior rating, the AEB system must avoid a crash or substantially reduce vehicle speed in *both* tests.

It is possible for a car with AEB to earn only a basic rating (for FCW) if the system fails to reduce vehicle speed by at least 5 mph in both track tests. A video on IIHS forward crash prevention systems and AEB testing can be viewed at **https://bit.ly/2XZGRS5**.

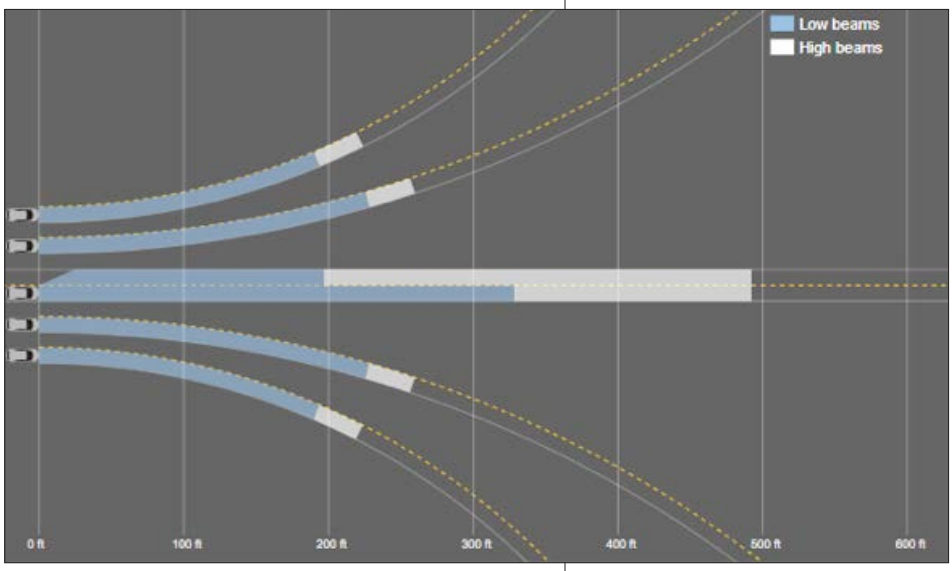
Headlights

Roughly half of U.S. traffic fatalities occur at night, and more than a quarter are on unlit roads. Clearly, headlights play a major role in vehicle safety. As lighting technology has progressed from halogen lamps to high-intensity discharge (HID) bulbs to light-emitting diodes (LEDs), car headlights have improved as well. In addition, many automakers now offer automatic high beams that increase lighting whenever it is possible to do so without blinding other drivers, and some cars can be equipped with headlights that turn with the steering to provide better illumination in curves.

Nonetheless, there is still a great deal of variation in headlight performance. The fact that a car has a newer bulb type does not necessarily mean it offers superior illumination. Differences in headlight design, reflector size and shape and even beam aiming can all have significant effects on how much light reaches the road. AAA **headlight research** found that at speeds above 45 mph headlights often fail to safely illuminate an unlit roadway.

Current government regulations forbid certain advanced headlight technologies and do not guarantee minimum lighting across a specified area ahead of the vehicle. In December 2018, AAA National submitted **comments** on a NHTSA proposal to update the FMVSS for vehicle lighting. AAA expressed support for new test protocols that would encourage the development of headlights that improve visibility and reduce glare for other drivers. A copy of AAA's Comparison of European and U.S. Specification Headlamp Performance report (publication pending) was included with the comments to NHTSA.

IIHS tests headlight low and high beams (aimed as delivered from the dealer) for the amount of light they deliver 10 inches above the road when travelling in a straight line, following a gradual (800-foot radius) curve and making a sharper (500-foot radius) turn. Test track sensors measure how far the headlight beams extend from the car while maintaining an intensity of at least 5 lux, which is roughly equivalent to twilight when there is just enough illumination to distinguish objects. The amount of low-beam glare produced for oncoming vehicles is also measured in each test at three feet seven inches above the road, and then scored as a percentage by which it exceeds a specified threshold.



Headlight test approaches and illumination distances. (Image: IIHS)

Headlights are scored good, acceptable, marginal or poor based on how well they compare to an "ideal" headlight system. Low beams are weighted more heavily than high beams because they are used more often, and straightaway readings are given greater credit because that is where more crashes occur.

Other IIHS Ratings

Although not currently part of its Top Safety pick ratings, IIHS does evaluate several other safety-related systems. These include rear crash prevention systems, pedestrian detection systems, youth booster seats and LATCH anchors for child safety seats.

Rear Crash Prevention

Testing rear crash prevention systems is a relatively new undertaking for IIHS. These technologies include parking sensors, rear cross-traffic warning and reverse automatic emergency braking – all intended to help drivers avoid collisions with vehicles or fixed objects when backing. The ratings are based on a points system with numbers earned for the presence of parking sensors and rear cross-traffic alert, and for the performance of a rear AEB system in a series of track tests at 4 mph. Based on the cumulative score, a vehicle's rear crash prevention rating can be superior, advanced or basic. For more information visit **https://bit.ly/2T8FBbE**.

Pedestrian Detection

Also new for IIHS is testing the pedestrian detection capabilities of FCW and AEB systems. Under the new program, vehicles rate as superior, advanced or basic based on their ability to avoid or mitigate a collision with pedestrian dummies in three different track tests run at different speeds. A video of IIHS pedestrian detection testing can be viewed at **https://bit.ly/2JProkk**.

A dummy being pulled in front of a moving vehicle for IIHS pedestrian detection testing.
(Image: IIHS)

Booster Seats

Booster seats are used for younger children (typically 4 to 8 years of age) who have outgrown child car seats but are not yet large enough to wear a seat belt properly. The seat raises them to a level where the belt crosses their body in the appropriate locations. IIHS tests booster seats using a special dummy that represents an average-size 6 year-old. Seat belt fit is measured in four conditions that cover the range of belt configurations in most vehicles. The seat is then assigned one of four ratings:

- Best Bet – Provides a good belt fit in almost any vehicle
- Good Bet – Provides an acceptable belt fit in most vehicles
- Not Recommended – Does not provide a good belt fit
- Check Fit – May provide a good or acceptable fit depending on the vehicle

LATCH System

Lower Anchors and Tethers for Children (LATCH) is a system of attaching hardware for child safety seats. Most seats can be installed using vehicle seat belts, but LATCH anchors are intended to help make proper installation easier. LATCH top tethers are needed for all forward-facing restraints to keep them from rotating forward and down in a crash.

Federal regulations require that most new cars provide full LATCH hardware in two rear seating positions, and at least a tether in a third seating position. Unfortunately, not all LATCH systems are easy to use. IIHS established a LATCH rating program in 2015 to encourage automakers to design hardware that meets certain ease-of-use criteria.

Anchor and tether locations on a typical vehicle rear seat.
(Image: IIHS)

IIHS ratings of LATCH systems take into account the accessibility of the lower anchors, the amount of force required to attach a restraint to the anchors, tether location and the presence of other hardware that might be confused with the tether. Based on these tests and evaluations, LATCH systems are rated good, acceptable, marginal or poor. For more information visit **https://bit.ly/2HIE5BA**.

Summary

NHTSA and IIHS vehicle safety ratings provide valuable information for car buyers concerned about protecting themselves and their passengers from the consequences of a collision. Each organization performs some unique tests, and both perform crash tests whose results complement one another to provide a more comprehensive picture of a vehicle's crash avoidance and mitigation capabilities.

In addition, both NHTSA and IIHS test and/or recommend additional safety systems and components that are not currently included as part of their vehicle safety ratings. The ratings for both organizations are periodically updated, so it is quite possible that some of these features will become part of their respective ratings in the future.

NHTSA and IIHS Safety Test Comparison

Frontal Crash				
NHTSA	Head-On Barrier			
IIHS	Moderate Overlap	Driver-Side Small Overlap	Passenger-Side Small Overlap	
Side Crash				
NHTSA	Side Barrier	Side Pole		
IIHS	Side Barrier			
Rollover/Roof Strength				
NHTSA	Rollover Proclivity			
	Static Stability Factor	Dynamic Stability Test		
IIHS	Angled Force Application			
Safety Technology				
NHTSA	No systems scored as part of the 5-Star Safety Ratings.			
IIHS	Forward Collision Warning	Automatic Emergency Braking	Headlights	Seat/Head Restraint

A comparison of the tests that contribute to NHTSA and IIHS vehicle safety ratings. (Image: AAA)

As the accompanying charts show, there is a lot to think about when evaluating a vehicle's safety. To help new-car buyers, NHTSA 5-Star Safety Ratings are printed on the vehicle window sticker, and detailed information for most new and used vehicles is available at **www.nhtsa.gov/ratings**. Automakers are also proud to identify vehicles that have won IIHS Top Safety Pick awards, and often do so in their advertising or by attaching special stickers to new cars. Detailed IIHS safety rating information for most new and used vehicles is available at **www.iihs.org/iihs/ratings**.

To make safe car buying easy, a consumer should pick a vehicle with a NHTSA 5-star *overall* safety rating or an IIHS Top Safety Pick+ rating. Better yet, a car that has received both of these honors will provide some of the best protection available today.

NHTSA and IIHS Safety Feature Comparison

Safety Technology recommended, but not scored or part of the 5-Star Safety Ratings				
NHTSA	Forward Collision Warning	Automatic Emergency Braking	Lane Departure Warning	Rearview Video System
Safety technology tested and scored, but not part of the Top Safety Pick ratings				
IIHS	Rear Crash Detection	Pedestrian Detection	Child Booster Seats	LATCH System

Safety features tested and/or recommended by NHTSA and IIHS, but not included in their safety ratings. (Image: AAA)

Endnotes

1 *Traffic Safety Facts*, National Highway Traffic Safety Administration, October 2018, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812603

2 CDC Winnable Battles Final Report, https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812603

To Learn More

Links to relevant online articles and other resources, including:

AAA SITES

Vehicle Safety and Performance, **AAA Exchange**
https://bit.ly/2O5WiUf

Transportation Safety, **AAA Exchange**
https://bit.ly/2OFly3X

AAA Offers Tips for Picking and Paying for the 'Right' *New Car,* AAA NewsRoom
https://bit.ly/2VctGeB

GOVERNMENT SITES

Crash Test Reports **(detailed information), safercar.gov**
https://bit.ly/2VbZvUU

Five-Star Safety Ratings, **National Highway Traffic Safety Administration**
www.nhtsa.gov/ratings

Five-Star Safety Ratings Frequently Asked Questions, **National Highway Traffic Safety Administration**
www.safercar.gov/Vehicle-Shoppers/5%E2%80%93Star-FAQ

New Car Assessment Program **(proposed changes), Federal Register / Vol. 83, No. 150 / Friday, August 3, 2018 / Notices**
www.gpo.gov/fdsys/pkg/FR-2018-08-03/pdf/2018-16653.pdf

New Car Assessment Program (NCAP); Safety Labeling, **National Highway Traffic Safety Administration**
https://bit.ly/2OFmB3T

NHTSA Vehicle Crash Test Database, **National Highway Traffic Safety Administration**
www-nrd.nhtsa.dot.gov/database/veh/veh.htm

Recalls and VIN Lookup FAQ, **National Highway Traffic Safety Administration**
www.safercar.gov/staticfiles/rulemaking/pdf/Recalls-FAQ.pdf

Vehicle Shoppers, **National Highway Traffic Safety Administration**
www.safercar.gov/Vehicle-Shoppers

INSURANCE SITES

Vehicle Safety Ratings, **Insurance Institute for Highway Safety**
www.iihs.org/iihs/ratings

What Do Crash Safety Ratings Really Mean?, **Liberty Mutual**
www.libertymutual.com/masterthis/crash-safety-ratings

OFFSHORE RATING SITES

European New Car Assessment Program, **Euro NCAP**
www.euroncap.com/en

Global New Car Assessment Programme, **Global NCAP**
www.globalncap.org

Japanese New Car Assessment Programme, **JNCAP**
www.nasva.go.jp/mamoru/en/

CONSUMER SITES

Consumer Reports Adds Passenger-Side Crash Test to Car Ratings**, Consumer Reports, September 5, 2018**
https://bit.ly/2VZOhD0

Crash Test Ratings: What's the Difference Between IIHS and NHTSA?**, Autotrader, April 2014**
https://bit.ly/2TRfNRJ

How to Check Car Safety Ratings, **Edmunds**
https://edmu.in/1htdoUJ

REFERENCE SITES

Euro NCAP, **Wikipedia**
https://en.wikipedia.org/wiki/Euro_NCAP

New Car Assessment Program, **Wikipedia**
https://en.wikipedia.org/wiki/New_Car_Assessment_Program