

Crashworthiness

refers to how well a vehicle protects its occupants in a crash, and the Insurance Institute for Highway Safety has evaluated aspects of the crashworthiness of five designs of midsize moderately priced cars representing six current models: Toyota Avalon, Volkswagen Passat, Saab 9-3, Mazda Millenia, and Nissan Maxima/Infiniti I30. Nine older models — Volvo 850/S70, Nissan Maxima/Infiniti I30 (two versions), Toyota Avalon (two versions), Saab 900, and Volkswagen Passat — also are evaluated.

The principal component of each vehicle's crashworthiness evaluation is performance in a 40 mph frontal offset crash test, and results show some differences. Two current models earn good overall evaluations and "best pick" designations: Avalon and Passat. The other models — 9-3, Millenia, and Maxima/I30 — earn acceptable evaluations. None of the current models is rated marginal or poor overall, although earlier Passat and Maxima models were rated poor. Only one of the nine earlier models earned a good overall evaluation: Volvo 850/S70 (which also is a "best pick").

Frontal Crash Testing

Today's passenger vehicles are designed to be more crashworthy than they used to be. Still, about 30,000 passenger vehicle occupants die in crashes on U.S. roads each year. Most of the deaths occur in frontal crashes.

Since the late 1970s, the federal New Car Assessment Program has compared frontal crashworthiness among new passenger

vehicles. This program, which involves 35 mph crash tests into a full-width rigid barrier, has been highly successful in providing consumers with comparative crashworthiness information. It also has been a major contributor to the crashworthiness improvements that characterize recent passenger vehicle models.

The very success of the New Car Assessment Program means remaining differences in performance among most new vehicles in full-width tests are small. This doesn't mean important crashworthiness differences no longer exist. They do exist, and additional crash test configurations can highlight these differences. One such test is the frontal offset crash.

Full-width and offset tests complement each other. Crashing the full width of a vehicle into a rigid barrier maximizes energy absorption so that the integrity of the occupant compartment, or safety cage, can be maintained well in all but very high-speed crashes. Full-width rigid-barrier tests produce high occupant compartment decelerations, so they're especially demanding of restraint systems. In offset tests, only one side of a vehicle's front end, not the full width, hits the barrier so that a smaller area of the structure must manage the crash energy. This means the front end on the struck side crushes more than in a full-width test, and intrusion into the occupant compartment is more likely. The bottom line is that full-width tests are especially demanding of restraints but less demanding of structure, while the reverse is true in offsets.

In the Institute's 40 mph offset test, 40 percent of the total width of each vehicle strikes a barrier on the driver side. The barrier's deformable face is made of aluminum honeycomb, which makes the forces in the test similar to those involved in a frontal offset crash between two vehicles of the same weight, each going just less than 40 mph. This means **test results can be compared only among vehicles of similar weight.** Like full-width crash test results, the results of offset tests cannot be used to compare vehicle performance across weight classes.

How the Institute Evaluates Vehicles

Each vehicle's offset crash test performance and overall evaluation are based on these criteria:

Structure/safety cage: Structural performance is based on measurements indicating the amount and pattern of intrusion into the occupant compartment during the offset test. This assessment indicates how well the front-end crush zone managed the crash energy and how well the safety cage limited intrusion into the driver space. Performance of the structure/safety cage is a major component of each vehicle's overall evaluation.

Injury measures: Obtained from a 50th percentile male Hybrid III dummy in the driver seat, injury measures are used to determine the likelihood that a driver would have sustained injury to various body regions. Measures are recorded from the head, neck, chest, and both legs and feet. Like structural performance, this assessment also is a major component of each vehicle's overall evaluation.

Restraints/dummy kinematics (movement): Significant injury risk can result from undesirable dummy kinematics — for example, partial ejection from the occupant compartment — in the absence of high injury measures. This aspect of performance involves how safety belts, airbags, steering columns, head restraints, and other aspects of restraint systems interact to control dummy movement. Although this assessment is important, it doesn't contribute as much as structural performance or injury measures to each vehicle's overall evaluation.

Head restraints: The basis of this evaluation is whether front-seat head restraints can be positioned behind and close enough to the back of an average-size male's head to limit relative head and torso movement in rear-end collisions — important because such movement often causes whiplash injuries. Evaluations of head restraints that have to be adjusted (either upward, or up and forward) for correct positioning depend on whether the restraints lock when they're adjusted. Those that don't lock are evaluated only in the unadjusted (down and back) position. Those that do lock are measured in both adjusted and unadjusted positions. But because head restraints usually aren't adjusted for correct positioning, ones that lock in position earn lower evaluations than fixed restraints with the same measurements.

Bumpers: Performance is assessed using the costs of repairing vehicle damage in a series of four crash tests at 5 mph — front- and rear-into-flat-barrier, front-into-angle-barrier, and rear-into-pole.

Overall evaluation: The three factors evaluated in the frontal offset crash test — structural performance, injury measures, and restraints/dummy kinematics — determine each vehicle's overall crashworthiness evaluation. The order in which vehicles are listed in this publication depends primarily on crash test performance, with head restraint and bumper evaluations influencing the rankings of vehicles with similar performance.

Evaluations

			Fronta	al Offset Cras	Other Evaluations			
		OVERALL EVALUATION	Structure/ Safety Cage	Injury Measures		Restraints/ Dummy Kinematics	- Head Restraint Design	Bumper Performance
Midsize moderately priced cars		OVERALL Evaluati		Head/ Neck Chest	Leg/Foot Left, Right			
best pick	TOYOTA AVALON 2000-01 models test vehicle wt. = 3,468 lbs.	G	G	G G	G G	G	A	A
best pick	VOLKSWAGEN PASSAT 1998-2001 models test vehicle wt. = 3,170 lbs.	G	G	GG	GG	A	M P depends on seat	G
	SAAB 9-3 1999-2001 models test vehicle wt. = 3,137 lbs.	A	A	A G	G A	M	G	A
	MAZDA MILLENIA 1995-2001 models test vehicle wt. = 3,183 lbs.	A	M	GG	PG	G	P	M
	NISSAN MAXIMA INFINITI I30 2000-01 models test vehicle wt. = 3,220 lbs.	A	A	GG	PP	G	G A depends on seat	M

G GOOD

A ACCEPTABLE

MARGINAL

POOR

Turn page for evaluations of earlier designs

Caution: The kinetic energy a vehicle must absorb in a crash test increases with vehicle weight, so barrier tests are more demanding of heavier vehicles. But occupants of heavier vehicles in real-world, two-vehicle crashes typically fare better than people in lighter vehicles (in many single-vehicle crashes, weight offers no safety advantage). This is why **test results shouldn't be compared among vehicles with large weight differences.**

Go to www.highwaysafety.org: This publication summarizes the crashworthiness evaluations of midsize moderately priced cars. The principal component of each vehicle's evaluation is its performance in a 40 mph frontal offset crash test. Details about each vehicle's test performance, including photographs taken during and after the crash test, are available online at www.highwaysafety.org. Or call the Institute for copies.



		Front	Other Evaluations			
	OVERALL Evaluation	Structure/ Safety Cage	Injury Measures	Restraints/ Dummy Kinematics	Head Restraint Design	Bumper Performance
Midsize moderately priced cars			Head/ Leg/Foot Neck Chest Left, Right			
Crashworthiness evaluations of earlier designs:						
VOLVO 850/S70 1995-2000 models test vehicle wt. = 3,131 lbs.	G	A	G G G	G	G	M
NISSAN MAXIMA INFINITI I30 1997-99 models test vehicle wt. = 3,104 lbs.	A	A	G G M A	A	A M depends on seat	G
TOYOTA AVALON 1998-99 models test vehicle wt. = $3,404$ lbs.	A	A	G G P G	A	depends on seat	A
TOYOTA AVALON 1995-97 models test vehicle wt. = 3,225 lbs.	M	M	G G P A	G	P	P
SAAB 900 1995-98 models test vehicle wt. = 3,020 lbs.	M	P	G G A	M	A	A
VOLKSWAGEN PASSAT 1995-97 models test vehicle wt. = 3,131 lbs.	P	M	G G P G	P	P	M
NISSAN MAXIMA 1995-96 models test vehicle wt. = 3,012 lbs. INFINITI I30 1996 models	P	A	M G P P	P	M	P





