Status Report

Insurance Institute for Highway Safety | Highway Loss Data Institute

In the dark

New ratings show most headlights need improvement

ALSO IN THIS ISSUE

Vol. 51, No. 3
March 30, 2016

The latest crash avoidance ratings from IIHS focus on some of the most basic, familiar equipment — headlights — and the results are dismal.

Out of 31 midsize cars evaluated, only one — the Toyota Prius v — is available with a headlight system that earns a good rating. The best available headlights on 11 cars earn an acceptable rating, while nine only reach a marginal rating. Ten of the vehicles can't be purchased with anything other than poor-rated headlights.

A vehicle's price tag is no guarantee of decent headlights. Many of the poor-rated headlights belong to luxury vehicles. The BMW 3 series has the lowest-scoring headlight system.

"If you're having trouble seeing behind the wheel at night, it could very well be your headlights and not your eyes that are to blame," says David Zuby, IIHS executive vice president and chief research officer.

The ability to see the road ahead, along with any pedestrians, bicyclists or obstacles, is an obvious essential for drivers. However, government standards for headlights, based on laboratory tests, allow huge variation in the amount of illumination that headlights provide in actual on-road driving. With about half of traffic deaths occurring either in the dark or in dawn or dusk conditions, improved headlights have the potential to bring about substantial reductions in fatalities.

Recent advances in headlight technology make it a good time to focus on the issue. In many vehicles, high-intensity discharge (HID) or LED lamps have replaced halogen ones. Curve-adaptive headlights, which swivel according to steering input, are also becoming more widespread, and IIHS and HLDI research shows that they are improving visibility and reducing crashes.

An IIHS study with volunteers found that curve-adaptive headlights on the 2013 Mazda 3 allowed drivers to spot a hard-to-see object on a dark, curvy road about 15 feet earlier than they did when the same model was equipped with conventional headlights. The study also found a benefit for HID headlights over halogen ones even when they were fixed (see *Status Report*, Oct. 9, 2014, at iihs.org).

Earlier HLDI analyses found that vehicles equipped with curve-adaptive headlights have lower claim rates for damage to other vehicles and, in most cases, for injuries to occupants of other vehicles and to other road users (see *Status Report*, July 3, 2012).

Developing a new test

Despite the research showing advantages for curve-adaptive and HID headlights, those features don't guarantee good headlight performance. When that fact became clear during preliminary testing, IIHS engineers developed a rating system that doesn't favor one lighting technology over the other, but simply rewards systems that produce ample illumination without excessive glare for drivers of oncoming vehicles.

The headlights are evaluated on the track after dark at the Vehicle Research Center. A special device measures the light from both low beams and high beams as the vehicle is driven on five different approaches: traveling straight, a sharp left curve, a sharp right curve, a gradual left curve and a gradual right curve.

IIHS Senior Research Engineer Matthew Brumbelow analyzed real-world nighttime crashes to determine the shape of the test curves and how much weight each portion of the test should carry.

Out of the shadows
These demonstrations show how low-beam visibility varies. In each photo, a target representing a pedestrian is located 50 feet from the vehicle, and two deer targets are 200 feet away.

To assess visibility, Brumbelow and other VRC engineers measure how far the light is projected so that it measures at least 5 lux. A lux is a unit of illuminance, or the amount of light falling on a surface.

For comparison, a full moon on a cloudless night illuminates the ground below to about 1 lux. Three lux is typically enough to make out low-contrast objects, but 5 lux can be more accurately measured and therefore works better as a threshold for the test.

Glare for oncoming vehicles also is measured from low beams in each scenario to make sure it isn't excessive.

Headlights are tested as received from the dealer. Although the vertical aim of headlights can be adjusted on most vehicles, IIHS doesn't change headlight aim because few vehicle owners ever do, and some manufacturers advise consumers not to.

"Many headlight problems could be fixed with better aim," Brumbelow says. "This is simple enough to adjust on many vehicles, but the burden shouldn't fall on the consumer to figure out what the best aim is. Manufacturers need to pay attention to this issue to make sure headlights are aimed consistently and correctly at the factory."

2016 midsize cars

Best available headlight system for each model

GOOD

Toyota Prius v

ACCEPTABLE

Audi A3
Honda Accord 4-door
Infiniti Q50
Lexus ES
Lexus IS
Mazda 6
Nissan Maxima
Volkswagen CC
Volkswagen Jetta
Volvo S60
Subaru Outback (built after Nov. 2015)

MARGINAL

Acura TLX
Audi A4
BMW 2 series
BMW 3 series
Chrysler 200
Ford Fusion
Lincoln MKZ
Subaru Legacy
Toyota Camry

POOR

Buick Verano
Cadillac ATS
Chevrolet Malibu
Chevrolet Malibu Limited (fleet model)
Hyundai Sonata
Kia Optima
Mercedes-Benz C-Class
Mercedes-Benz CLA
Nissan Altima
Volkswagen Passat

For trim and package specifications for the listed ratings and for ratings of other systems available on these models, visit **iihs.org/ratings**

Translating test results into ratings

After a vehicle is tested on the track, IIHS engineers compare its visibility and glare measurements to those of a hypothetical ideal headlight system and use a scheme of demerits to determine the rating. In this system, the low beams are weighted more heavily than the high beams because they are used more often. The readings on the »

Headlight ratings: best, worst and glaring

The Prius v has the only headlights to earn a good rating so far, while the BMW 3 series halogen lights are the worst tested. The Kia Optima earns a poor rating because of badly aimed headlights that create excessive glare.

2016 Toyota Prius v

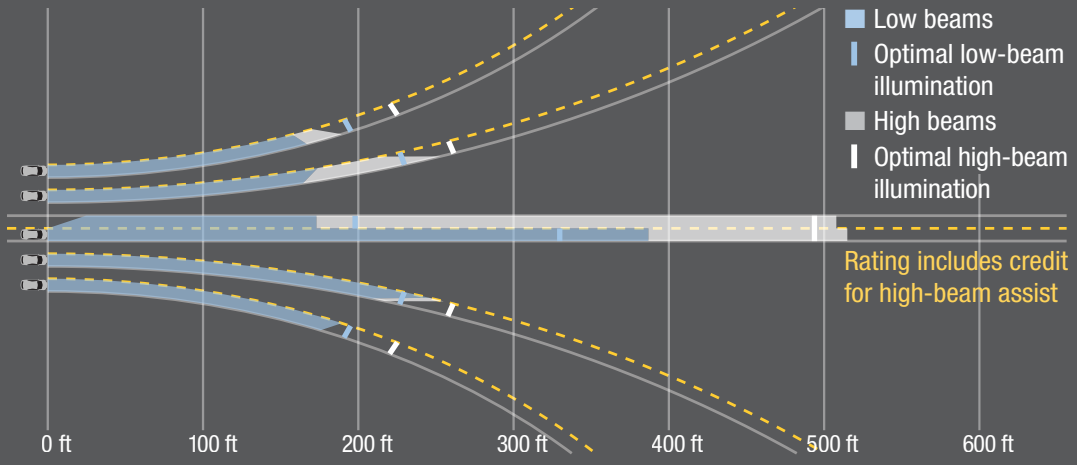
Trim: **Five**
Package: **Advanced Technology**
Headlight type: **LED projector**

Automatically switches between low beams and high beams (high-beam assist)? **Yes**

Overall rating: G

Note: Low-beam performance carries the most weight.

Distance at which headlights provide at least 5 lux illumination



2016 BMW 3 series

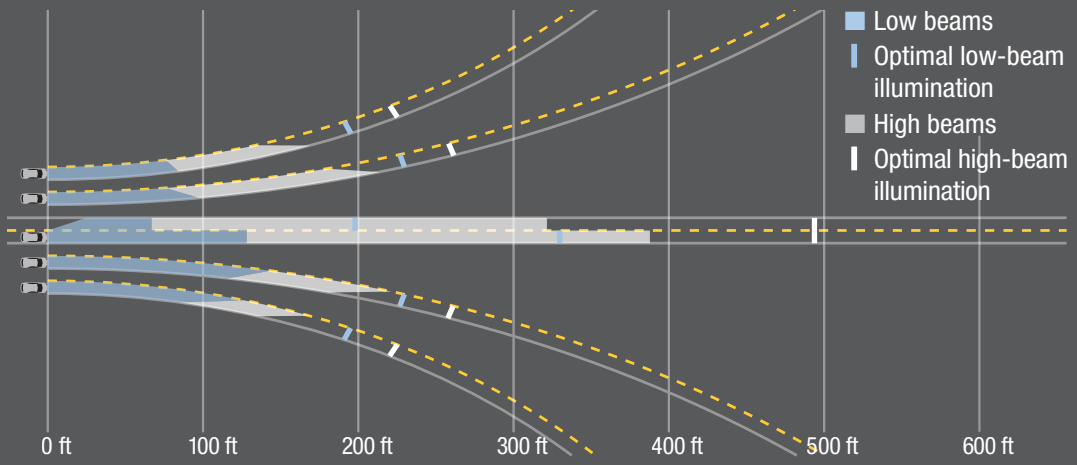
Trim level: **320, 328, 330**
Package: **None**
Headlight type: **halogen reflector**

Automatically switches between low beams and high beams (high-beam assist)? **No**

Overall rating: P

Note: Low-beam performance carries the most weight.

Distance at which headlights provide at least 5 lux illumination



2016 Kia Optima

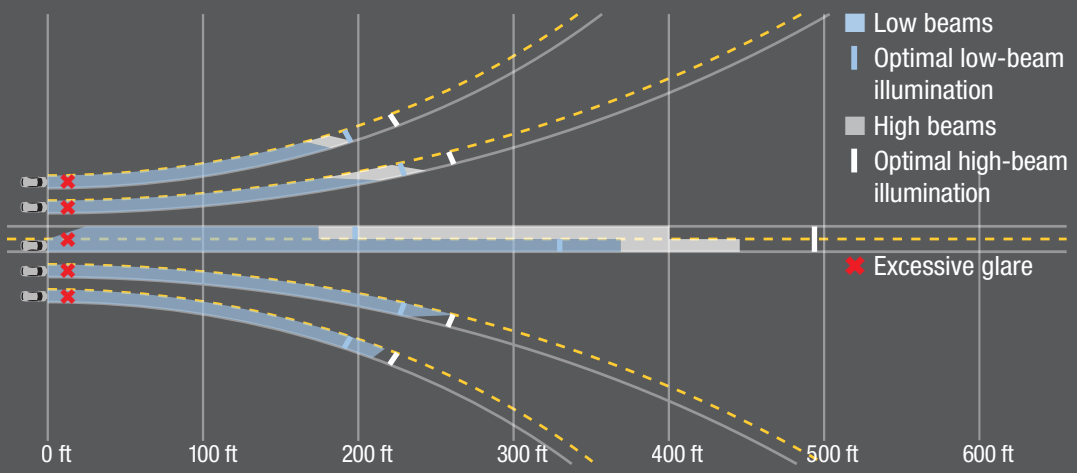
Trim level: **SX, SX Limited**
Package: **Technology**
Headlight type: **HID projector**

Automatically switches between low beams and high beams (high-beam assist)? **Yes**

Overall rating: P

Note: Low-beam performance carries the most weight.

Distance at which headlights provide at least 5 lux illumination



Few drivers use their high beams, study finds

While the headlights on most cars need improvement, there is one simple thing that drivers can do to improve visibility in any vehicle: use their high beams. A recent study, however, shows that drivers rarely turn them on.

The finding supports the Institute's decision to award extra credit in its new headlight ratings for high-beam assist, a feature that automatically switches between low beams and high beams, depending on whether other vehicles are present.

Researchers from IIHS and the University of Michigan Transportation Research Institute observed high-beam use at night on roads around Ann Arbor, Mich. The observation sites included both rural roads and urban streets, and all but one had poor or nonexistent lighting. Some of the roads were straight, and some were winding.

The researchers deemed a vehicle isolated enough to use high beams if other vehicles were 10 seconds or more away.

Of about 3,200 isolated vehicles observed, 18 percent of vehicles had their high beams on. At one unlit urban location, use was less than 1 percent. Even on rural roads, drivers on average used their high beams less than half of the time they should have for maximum safety.

The researchers also conducted a telephone survey of drivers in the Ann Arbor area and found that drivers overestimate how often they use their high beams when compared with what the observations showed. More than 80 percent of respondents said they use their high beams most or all of the time on rural roads.

"It may be that drivers are being too polite and keeping their 'brights' off whenever there are other vehicles in sight — even if those vehicles are far enough away not to be bothered by the glare," IIHS Senior Research Scientist Ian Reagan says. "Another possibility is that they are simply forgetting to switch to high beams. In either case, high-beam assist could be a good solution."

To be an effective remedy, however, high-beam assist will need to be embraced by consumers. The survey showed that some people may be reluctant to drive a vehicle with the technology. Only 43 percent of survey respondents said they would like to own a vehicle equipped with high-beam assist.

"A third possible explanation for the low rate of high beam use is that drivers believe they see fine without them," Reagan adds. "If that's the case, they may not see the point in purchasing a vehicle with high-beam assist and activating the feature."

Of the 31 midsize luxury and nonluxury cars for which IIHS is releasing headlight ratings, 18 have available high-beam assist.

For a copy of "The effects of rurality, proximity of other traffic, and roadway curvature on high-beam headlamp use rates" by I.J. Reagan et al., email publications@iihs.org. ■

(« *from p. 3)* straightaway are weighted more heavily than those on curves because more crashes occur on straight sections of road.

A vehicle with no demerits doesn't exceed the low-beam glare threshold on any approach and provides illumination to at least 5 lux over specified distances, ranging from nearly 200 feet for low beams on a sharp curve to nearly 500 feet for high beams on the straightaway.

Vehicles equipped with high-beam assist, which automatically switches between high and low beams depending on the presence of other vehicles, may earn back some points taken off for less-than-ideal low-beam visibility. This credit is given only for approaches on which the glare threshold isn't exceeded and on which high beams improve visibility compared with low beams.

A vehicle with excessive glare on any of the approaches can't earn a rating above marginal.

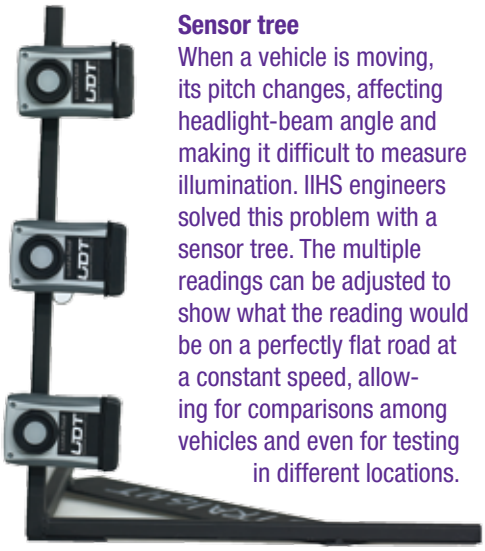
One good rating out of 82

Most of the vehicles included in this release have multiple headlight ratings, so there are a total of 82 headlight ratings for 2016 models even though there are only 31 vehicles. IIHS is rating every possible headlight combination as it becomes available from dealers.

The Prius v earns a good rating when equipped with LED lights and high-beam assist. The low beams cover a distance of nearly 400 feet in the right lane while traveling straight and about 160-210 feet on the curves. The high beams extend more than 500 feet on the straightaway and about 180-220 feet on the curves. Neither the low beams nor the high beams are curve adaptive. The car's performance on curves might be improved if that feature was added.

Consumers who want the good headlights on the Prius v need to buy the advanced technology package, which is only available on the highest trim level. When equipped with regular halogen lights and without high-beam assist, the Prius v earns a poor rating.

"The Prius v's LED low beams should give a driver traveling straight at 70 mph enough time to identify an obstacle on the right side of the road, where the light is best, and brake to a stop," Brumbelow says. "In contrast, someone with the halogen »



Sensor tree

When a vehicle is moving, its pitch changes, affecting headlight-beam angle and making it difficult to measure illumination. IIHS engineers solved this problem with a sensor tree. The multiple readings can be adjusted to show what the reading would be on a perfectly flat road at a constant speed, allowing for comparisons among vehicles and even for testing in different locations.

(« *from p. 5)* lights would need to drive 20 mph slower in order to avoid a crash."

Among the 44 headlight systems earning a poor rating, the halogen lights on the BMW 3 series are the worst. The low beams illuminate only about 130 feet on the right side of the straightaway. A driver with those headlights would have to be going 35 mph or slower to stop in time for an obstacle in the travel lane. The system's high beams don't reach 400 feet. A better choice for the same car is an LED curve-adaptive system with high-beam assist, a combination that rates marginal.

Curve-adaptive systems don't always lead to a better rating, however. The Cadillac ATS, Kia Optima and Mercedes-Benz C-Class all earn poor ratings, even when equipped with adaptive low and high beams.

In the case of the Optima, a big problem is glare. Its curve-adaptive system provides better visibility than its nonadaptive lights, but produces excessive glare for oncoming vehicles on all five low-beam approaches.

IIHS engineers test headlights at night on the outdoor track at the Vehicle Research Center in Ruckersville, Va.

One of the best headlight systems evaluated has none of the new technology. The basic halogen lights on the Honda Accord sedan earn an acceptable rating, while an LED system with high-beam assist available on the Accord earns only a marginal. ■

Changes coming to federal 5-star safety ratings program

The federal government's New Car Assessment Program (NCAP) is poised to get a makeover under a sweeping proposal that would add a new oblique frontal crash test, new dummies, and new ratings for crash avoidance and pedestrian protection. The Institute urges regulators to focus on the quick wins, while postponing other changes that need more study and longer time to implement.

The timetable for updating the 38-year-old program is aggressive. By year's end, the National Highway Traffic Safety Administration (NHTSA) intends to finalize the changes and begin ratings under the new system in 2018 for model-year 2019 vehicles. The agency asked for public comments on its proposal, which it issued in December 2015.

"The Institute strongly supports efforts to provide consumers with enhanced vehicle safety information that rewards auto manufacturers who lead the industry in safety advancements and encourages others to improve," Joe Nolan, IIHS senior vice president for vehicle research, said in the Institute's Feb. 16 comment to the agency.

NHTSA crash-tests new vehicles and rates them on how well they protect people in full-frontal, side and rollover crashes. Vehicles get a rating of 1 to 5 stars. The IIHS vehicle ratings program, which began in 1995, complements NCAP and has grown to include offset front, side, rollover and rear tests, automatic braking tests and, now, headlights.

The broad changes NHTSA is proposing should help raise the bar on safety. In particular, crash avoidance technology evaluations and enhanced protection for pedestrians struck by passenger vehicles are important improvements. Some of the proposed changes, however, aren't detailed enough to allow for a thorough review, while others aren't fully supported by scientific data.

The revamped 5-star safety ratings would include a crash avoidance rating based on whether or not a vehicle has one or more of nine features and how they perform in NCAP tests. These include: forward collision warning and automatic emergency braking; lane departure warning; blind spot detection; frontal pedestrian autobrake; rear pedestrian autobrake; high-performing low-beam headlights; high-beam assist; and amber rear-turn-signal lamps.

IIHS notes that some crash avoidance features have more support than others. In particular, lane departure warning hasn't been found to reduce insurer-reported crashes and is often disabled by drivers (see *Status Report*, Jan. 28, 2016, at iihs.org). NCAP already awards credit for lane departure warning, but NHTSA aims to modify the existing performance criteria. Even with the proposed test

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changes, IIHS believes the agency should shelve lane departure warning credit until the systems' real-world benefits are established. That would give manufacturers the freedom to design new systems that are effective and acceptable to drivers.

A new pedestrian protection rating would be based on the performance of autobrake systems capable of detecting and braking for pedestrians in front of or behind a vehicle and impact testing of the front of a vehicle to evaluate injury risk when impacts occur. IIHS supports the impact tests. Although there is a lack of evidence on rear autobrake's effectiveness, the technology has the potential to prevent more crashes than rear cameras alone.

IIHS urges NHTSA to take into account how IIHS and Euro NCAP are evaluating the performance of crash avoidance technologies and diverge from these procedures "only when there is empirical evidence that doing so will bring measurable benefits."

NHTSA plans to add a new crash test to measure how well vehicles protect people in an angled frontal crash. The test would use the THOR 50th percentile male dummy in the driver seat and the modified Hybrid III 5th percentile female dummy in the right rear seat. The vehicle would be stationary and struck by a moving barrier at a 15-degree angle, with a 35 percent overlap and 56 mph impact speed. The test would simulate two midsize vehicles colliding with a 50 percent overlap and an impact speed of 35 mph, the same severity as NCAP's full-width frontal rigid barrier test.

Vehicle mass will be a dominant performance factor in the moving barrier test, giving bigger, heavier vehicles, such as large cars, the edge over smaller, lighter ones, such as minicars. There might not be large differences among ratings within a vehicle class, which will make it difficult to determine, for example, which small cars are safer than others. Since consumers tend to focus on a certain group when shopping for a vehicle, NHTSA should ensure that its new test highlights meaningful differences in the performance of similar-size vehicles.

In addition, IIHS strongly recommends that NHTSA delay use of a proposed head injury metric known as the Brain Rotational Injury Criterion, or BrIC. Numerous studies indicate that BrIC, as currently calculated, significantly overestimates injury risk and doesn't align with real-world data. IIHS also recommends NHTSA penalize vehicles with excessive occupant compartment intrusion in the test. Minimizing intrusion is key to protecting occupants from serious injuries in crashes.

IIHS agrees that crash tests should use the most biofidelic dummies available but notes that NHTSA hasn't supplied any comparative data to show that THOR, the modified Hybrid III 5th percentile female and the WorldSID 50th percentile male it proposes to use would provide more benefits and drive better vehicle designs than the dummies currently used. What's more, these dummies haven't been finalized in federal standards and aren't readily available.

The upgraded NCAP would feature an overall safety rating combining the results for crashworthiness, crash avoidance and pedestrian protection. IIHS recommends that NHTSA continue to publish ratings indicating how vehicles perform in individual tests.

NCAP would give half-credit for optional crash avoidance systems. Nolan points out that the practice could mislead consumers since standard systems would always score better, even if they don't perform as well as optional systems. IIHS urges NHTSA to evaluate vehicles both with and without the crash avoidance technologies and publish dual ratings in the case of optional features. IIHS incorporated this strategy when a mix of optional and standard side airbags was in the fleet to provide clear indication of the airbags' benefit to consumers. ■

Planned additions to NHTSA's 5-star safety ratings program include:

- Crash avoidance rating, including headlights
- Pedestrian protection rating
- Frontal oblique crash test
- New dummies and injury criteria
- Half-star rating increments
- Half-credit for optional crash avoidance technologies

The National Highway Traffic Safety Administration

The THOR 50th percentile male dummy would replace the Hybrid III dummy in NCAP tests under NHTSA's proposal.

Insurance Institute for Highway Safety
Highway Loss Data Institute

Status Report

Vol. 51, No. 3
March 30, 2016

Inquiries/print subscriptions:
StatusReport@iihs.org

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Editor: Kim Stewart
Writer: Sarah Karush
Art Director: Steve Ewens

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HLDI 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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