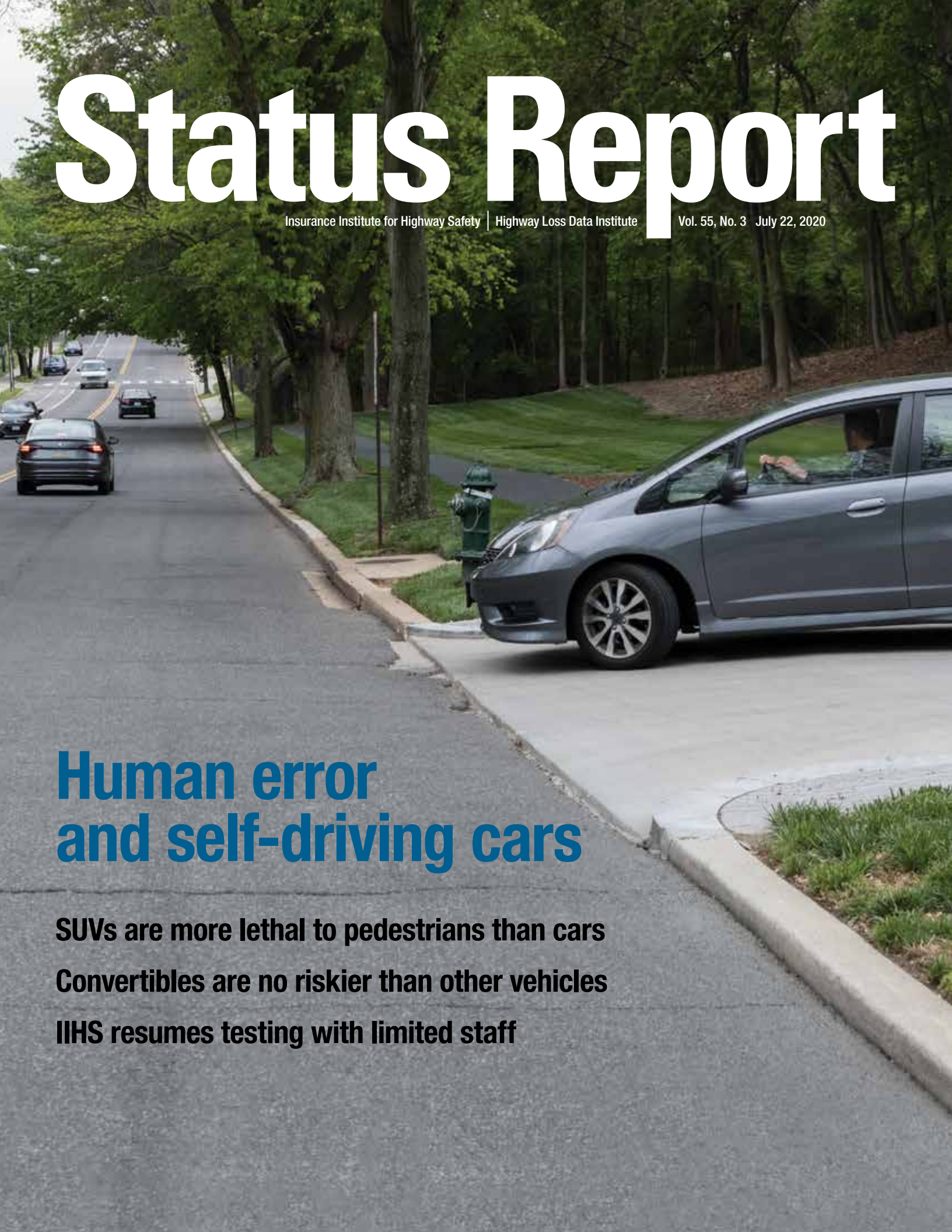


Status Report

Insurance Institute for Highway Safety | Highway Loss Data Institute Vol. 55, No. 3 July 22, 2020

Human error and self-driving cars

SUVs are more lethal to pedestrians than cars

Convertibles are no riskier than other vehicles

IIHS resumes testing with limited staff

Autonomous vehicle design should take nothing for granted

Driver mistakes play a role in virtually all crashes. That's why automation has been held up as a potential game changer for safety. But autonomous vehicles might prevent only around a third of all crashes if automated systems drive too much like people, according to a new study from IIHS.

"It's likely that fully self-driving cars will eventually identify hazards better than people, but we found that this alone would not prevent the bulk of crashes," says Jessica Cicchino, IIHS vice president for research and a coauthor of the study.

Conventional thinking has it that self-driving vehicles could one day make crashes a thing of the past. According to a national survey of police-reported crashes, driver error is the final failure in the chain of events leading to more than 9 out of 10 crashes.

Self-driving vehicles would only avoid about a third of the errors that lead to crashes unless they're designed to prioritize safety over other concerns.

But the Institute's analysis suggests that only about a third of those crashes were the result of mistakes that automated vehicles would be expected to avoid simply because they have more accurate perception than human drivers and aren't vulnerable to incapacitation. To avoid the other two-thirds, they would need to be specifically programmed to prioritize safety over speed and convenience.

"Building self-driving cars that drive as well as people do is a big challenge in itself," says IIHS Research Scientist Alexandra Mueller, lead author of the study. "But they'd actually need to be better than that to deliver on the promises we've all heard."

To estimate how many crashes might continue to occur if self-driving cars are designed to make the same decisions about risk that humans do, IIHS researchers examined more than 5,000 police-reported crashes from the National Motor Vehicle Crash Causation Survey. Collected by the National Highway Traffic Safety Administration, this sample is representative of crashes across the U.S. in which at least one vehicle was towed away and emergency medical services were called to the scene.

The IIHS team reviewed the case files and separated the driver-related factors that contributed to the crashes into five categories:

IIHS RESEARCH

"What humanlike errors do autonomous vehicles need to avoid to maximize safety?" by A.S. Mueller, J.B. Cicchino, and D.S. Zuby

To request this paper, email researchpapers@iihs.org.

- **Sensing and perceiving errors** included things like driver distraction, impeded visibility and failing to recognize hazards before it was too late.
- **Predicting errors** occurred when drivers misjudged a gap in traffic, incorrectly estimated how fast another vehicle was going or made an incorrect assumption about what another road user was going to do.
- **Planning and deciding errors** included driving too fast or too slow for the road conditions, driving aggressively or leaving too little following distance from the vehicle ahead.
- **Execution and performance errors** included inadequate or incorrect evasive maneuvers, overcompensation and other mistakes in controlling the vehicle.
- **Incapacitation** involved impairment due to alcohol or drug use, medical problems or falling asleep at the wheel.

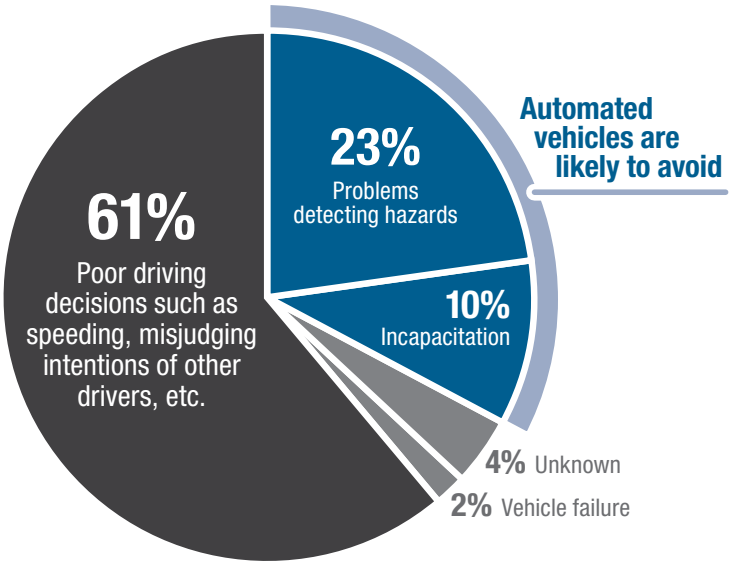
The researchers also determined that some crashes were unavoidable, such as those caused by a tire blowout or broken axle.

For the study, the researchers imagined a future in which all the vehicles on the road are self-driving. They assumed these future vehicles would prevent those crashes that were caused exclusively by perception errors or involved an incapacitated driver. That's because cameras and sensors of fully autonomous vehicles could be expected to monitor the roadway and identify potential hazards better than a human driver and be incapable of distraction or incapacitation.

An Uber autonomous vehicle on the streets of Washington, DC

Crashes due to only sensing and perceiving errors accounted for 23 percent of the total, and incapacitation accounted for 10 percent. Those crashes might be avoided if all vehicles on the road were self-driving — though it would require sensors that worked perfectly and systems that never malfunctioned. The remaining two-thirds might still occur unless autonomous vehicles are also specifically programmed to avoid other types of predicting, decision-making and performance errors.

Contributing factors in police-reported passenger vehicle crashes, 2005-07



Consider the crash of an Uber test vehicle that killed a pedestrian in Tempe, Arizona, in March 2018. Its automated driving system initially struggled to correctly identify 49-year-old Elaine Herzberg on the side of the road. But once it did, it still was not able to predict that she would cross in front of the vehicle, and it failed to execute the correct evasive maneuver to avoid striking her when she did so.

Planning and deciding errors, such as speeding and illegal maneuvers, were contributing factors in about 40 percent of crashes in the study sample. The fact that deliberate decisions made by drivers can lead to crashes indicates that rider preferences might sometimes conflict with the safety priorities of autonomous vehicles. For self-driving vehicles to live up to their promise of eliminating most crashes, they will have to be designed to focus on safety rather than rider preference when those two are at odds.

Self-driving vehicles will need not only to obey traffic laws but also to adapt to road conditions and implement driving strategies that account for uncertainty about what other road users will do, such as driving more slowly than a human driver would in areas with high pedestrian traffic or in low-visibility conditions.

"Our analysis shows that it will be crucial for designers to prioritize safety over rider preferences if autonomous vehicles are to live up to their promise to be safer than human drivers," Mueller says. ■

New study suggests today's SUVs are more lethal to pedestrians than cars

Though their designs have changed considerably over the past two decades, late-model SUVs still appear to be more likely than cars to kill pedestrians, IIHS researchers have found.

Thanks to advances in safety, the number of people killed in motor vehicle crashes in the U.S. has fallen from more than 50,000 in 1980 to 36,560 in 2018. Over the past decade, however, the number of pedestrians killed on American roads has ticked steadily upward.

"The proportion of SUVs in the U.S. fleet has grown dramatically, so it's discouraging that they still seem to be more deadly to pedestrians than cars are," says IIHS Statistician Sam Monfort, lead author of the study.

At speeds above 19 mph, SUVs caused more serious injuries than cars in a sample of 79 crashes.

IIHS RESEARCH

"Pedestrian injuries from cars and SUVs: updated crash outcomes from the Vulnerable Road User Injury Prevention Alliance (VIPA)" by S.S. Monfort and B.C. Mueller

To request this paper, email researchpapers@iihs.org.

Analyzing a sample of 79 crashes from three urban areas in Michigan, the researchers found greater risk to pedestrians from SUVs. Because the sample size is small and limited to one geographic region, more research will be required to see whether all of the findings hold up in a larger study.

In the Michigan crashes, SUVs caused more serious injuries than cars when impacts occurred at greater than 19 miles per hour. At speeds of 20-39 mph, 3 out of 10 crashes with SUVs (30 percent) resulted in a pedestrian fatality, compared with 5 out of 22 for cars (23 percent). At 40 mph and higher, all three crashes with SUVs killed the pedestrian (100 percent), compared with 7 out of 13 crashes involving cars (54 percent). Below 20 miles per hour there was little difference between the outcomes, with pedestrians struck by either vehicle type tending to sustain minor injuries.

The number of pedestrians killed by vehicles rose 53 percent from 2009 to 2018, the latest year for which statistics are available. Over the same period, the share of SUVs in the U.S. passenger vehicle fleet rose to 29 percent from 21 percent, according to vehicle registration data from IHS Markit. Pedestrians now account for nearly a fifth of all traffic fatalities — a proportion not seen since the early 1980s.

A previous IIHS study found that pedestrian crashes have become both deadlier and more frequent (See "Study highlights rising pedestrian deaths, points toward solutions," May 8, 2018). Although pedestrian crashes most frequently involved cars, fatal single-vehicle crashes involving SUVs striking pedestrians increased 81 percent from 2009 to 2016, more than those involving any other type of vehicle.

Earlier research had shown that SUVs, pickup trucks and passenger vans were 2-3 times more likely than cars to kill a pedestrian in the event of a crash. However, most earlier studies were based on crash data collected in the 1970s, 80s and 90s. Since then, SUV manufacturers have made substantial design changes.

To provide an updated comparison, IIHS researchers analyzed detailed crash data compiled by the International Center for Automotive Medicine Pedestrian Consortium. Each crash involved one SUV or car and one pedestrian over the age of 13. The median model year for the vehicles involved was 2009, and three-quarters of them were built between 2004 and 2013.

The Michigan crashes are not necessarily representative of those that occur nationwide. However, the injury patterns were consistent with earlier, national studies in showing that SUVs were more likely than cars to throw pedestrians forward and nearly twice as likely to cause severe hip and thigh injuries. These injuries were mainly caused by impacts with the bumper, grille or headlights. That's likely because the high point of the front profile, or "leading edge," of most new SUVs is still considerably higher than that of the average car.

In recent years various SUV manufacturers have adopted more carlike designs. Part of those changes were intended to address the risk that SUVs posed to car occupants. Bumpers and other force-absorbing structures were lowered so that they aligned better with those of cars. As a result, SUVs no longer pose a greater threat to the occupants of other vehicles than cars of comparable weight (See "SUVs no longer pose outsize risk to car occupants, but pickups lag," October 10, 2019).

There hasn't been a similar widespread effort to address the danger that SUVs pose to pedestrians, and the changes made to improve compatibility with cars wouldn't be expected to improve outcomes for pedestrians. In pedestrian crashes, the location of the force-absorbing structures is less important than the overall shape of the front end.

In a crash with a traditional, blockfront SUV, the grille strikes the pedestrian's pelvis or chest split seconds after the bumper hits the lower extremities, transferring more energy to the pedestrian's body. It's possible that a more sloping profile could do less damage.

IIHS plans to use the Michigan crash data to look into what kind of SUV profile poses the least risk to struck pedestrians.

Europe has also introduced pedestrian airbags and other features that have been shown to mitigate injuries in crashes with cars, but the small portion of SUVs in the European fleet means there isn't much evidence to show how effective they have been for these taller, blockier vehicles.

"Our findings provide more evidence that manufacturers need to make design changes to help combat the increase in pedestrian fatalities now that more of the vehicles on the road are SUVs," says IIHS Senior Research Engineer Becky Mueller. ■

Crash statistics show no added risk for convertibles

Convertibles may not look as safe as other vehicles when they're cruising down the highway with the top down, but crash statistics tell a different story, a new IIHS study shows.

Despite the relatively flimsy appearance of their roof structures, late-model convertibles are no riskier than nonconvertibles, according to the analysis of crash and fatality rates.

In fact, both crash rates and driver death rates were lower for convertibles than for nonconvertible versions of the same cars. However, the differences in driver death rates weren't statistically significant.

"These findings don't suggest that convertibles offer better protection for their occupants than other cars, but they do indicate there's no statistical basis for concerns that the lack of a permanent roof makes them more dangerous," says Eric Teoh, IIHS director of statistical services, who wrote the paper.

Teoh compared the rates of driver deaths and police-reported crashes per miles traveled for convertible and nonconvertible versions of 1-5-year-old models during 2014-18. He also compared the circumstances and driver behaviors associated with the fatal crashes, looking at factors like point of impact and whether the driver was ejected from the vehicle, as well as impairment and seat belt use.

Eric Teoh, the author of the new paper, in his BMW 4 series

Data on drivers killed in crashes came from the Fatality Analysis Reporting System maintained by the National Highway Traffic Safety Administration (NHTSA). Information about the number of police-reported crashes was from the National Automotive Sampling System General Estimates System and the Crash Report Sampling System that replaced it in 2016, also maintained by NHTSA.

Teoh found that convertibles were involved in 6 percent fewer police-reported crashes per mile traveled than their »

IIHS RESEARCH

"Crash rates of convertible cars" by E.R. Teoh

To request this paper, email researchpapers@iihs.org.

(« *from p. 5)* conventional counterparts. Driver death rates were 11 percent lower. However, the likelihood that the driver was ejected from the vehicle in the event of a fatal crash was higher for convertibles than conventional versions.

Previous research has shown that for conventional cars a stronger roof reduces the risk of a serious or fatal injury as well as the likelihood of ejection in the event of a rollover crash. IIHS added a roof-strength evaluation to its crashworthiness testing program in 2009, making a good rating a requirement for the *TOP SAFETY PICK* award a year later.

Both stretched-fabric and retractable-hardtop convertibles are exempt from NHTSA's current roof-crush resistance requirements. However, some manufacturers have voluntarily strengthened the A-pillars on either side of the windshield and installed roll bars to provide additional protection in rollover crashes.

When IIHS evaluated a group of midsize convertibles in 2007, most of the 10 models earned good or acceptable ratings in the front and side crash tests, though eight had poor or marginal head restraints. Since then, convertibles have remained a low priority for the testing program due to their small sales volumes.

There was little difference in the circumstances of fatal crashes for convertibles and nonconvertibles. In both cases, around a quarter of fatalities occurred in rollover crashes.

This year, the IIHS-affiliated Highway Loss Data Institute also compared insurance claims data for vehicles available in both convertible and nonconvertible versions, finding that the convertibles had lower injury rates and collision claim rates.

Teoh found little difference in most of the circumstances of the fatal crashes for convertible and nonconvertible vehicles. In both cases, around a quarter of the fatalities occurred in rollover crashes, about half occurred in single-vehicle crashes, roughly 60 percent resulted from front-impact crashes, and about 20 percent from side-impact crashes.

However, 21 percent of the convertible drivers killed in crashes were ejected from the vehicle, compared with 17 percent for conventional cars. Among rollover crashes, the likelihood of ejection was 43 percent for convertibles versus 35 percent for their nonconvertible counterparts.

Convertible drivers were slightly more likely to be wearing seat belts and slightly less likely to be speeding, though they were a bit more likely to be impaired by alcohol. These differences were too small to suggest a big variation in driver behavior for the two vehicle types.

Teoh wasn't able to account for all possible differences in the way convertibles are driven, even when comparing with the nonconvertible version of the same car. For example, it may be that convertible owners more often drive them in nice weather or on less busy roads, and that could affect crash rates.

"Based on this study, convertibles don't appear to pose a particular safety risk," Teoh said. "If you're shopping for a convertible, you should consider crash test ratings and safety features, just as you would if you were shopping for any other car." ■

IIHS reopens test facility with health precautions

Employees have returned to the IIHS Vehicle Research Center (VRC) on a limited basis, resuming work that had to be paused amid the COVID-19 pandemic.

IIHS closed both the VRC, located in Ruckersville, Virginia, and its Arlington, Virginia, office in March, as the state was shutting down. Much of the Institute's work continued, with employees working from home, but crash tests and track evaluations had to be paused.

Virginia began a phased reopening in May. In addition to state guidelines, IIHS used supplemental criteria to ensure that the health situation in the area around the VRC was improving before attempting to reopen the facility. The Arlington office remains closed.

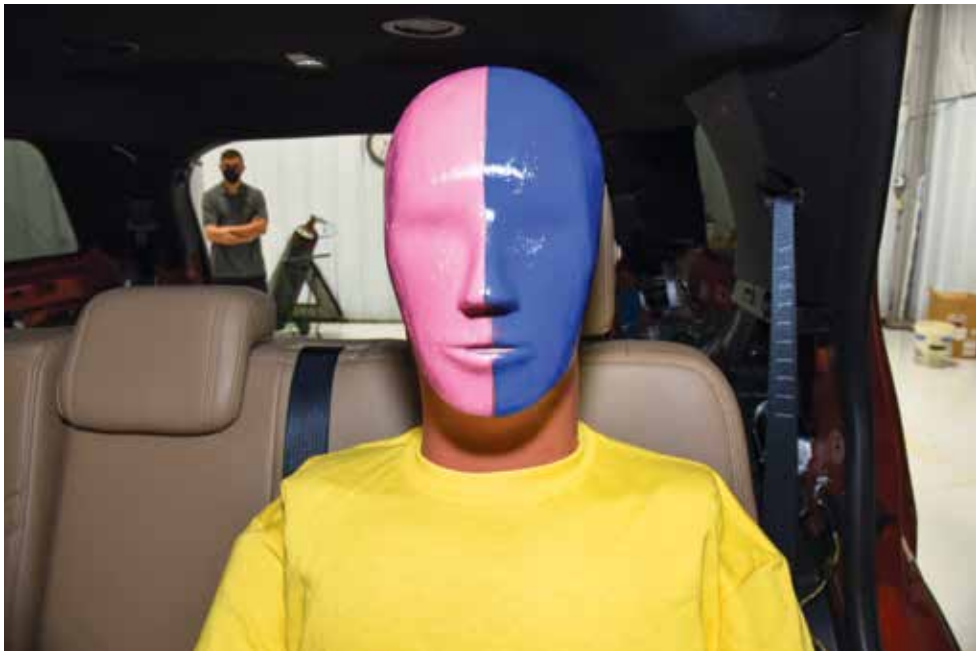
On June 15, a skeleton crew returned to work at the VRC and that week conducted the first crash test there since March. The test involved a Chrysler Pacifica minivan striking a rigid wall at 35 mph. The demonstration will be used to update some of the Institute's educational videos. The driver dummy and two child dummies were unbelted.

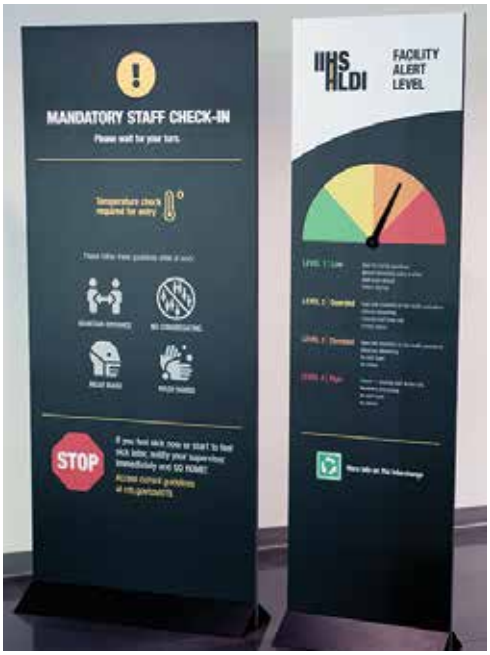
"We're following the same rigorous protocols as we always do for our crash tests, plus some important new ones," says IIHS Chief Administrative Officer Joe Nolan. "The only employees around for the crash tests are those who absolutely need to be there, and, of course, there are no visitors observing the action."

In addition to crash testing, evaluations of headlights and front crash prevention systems — both vehicle-to-vehicle and vehicle-to-pedestrian — have also resumed. One employee drives each car in all of those tests in order to avoid the need to sanitize it between tests.

For now, VRC employees who can telework are continuing to do so. Those needed for on-site work are split into two teams working alternating weeks.

Everyone at the VRC must wear masks unless they are in an office or vehicle by themselves and must adhere to a rigorous cleaning





protocol. If employees need to get within six feet of each other, they must also wear face shields.

All vehicles delivered to the VRC, whether borrowed or purchased, are parked and not touched for two days. If a vehicle is needed sooner, it can be sanitized by raising the temperature inside to 130 degrees Fahrenheit for 20 minutes or 150 degrees for 5 minutes to bypass the isolation period. The method is based on a system that Ford recently developed for police to use with its cruisers. While Ford has special software for the process, IIHS simply uses sunlight and the vehicle's climate control system (plus auxiliary heaters if needed) to raise the temperatures to the specified sanitization levels.

Inside the building, HVAC settings have been changed to increase fresh air intake, and HEPA filters have been installed in certain closed-off areas. In the crash hall and other areas, doors are opened and exhaust fans are being run regularly.

"These new procedures are enabling us to safely get back to our important testing and safety research," Nolan says. "We are grateful to our employees for their flexibility and diligence as we work through these new challenges."

Even as crash testing was paused, VRC staff have been able to continue publishing the safety ratings that consumers rely on. Many ratings in long-established tests are based on crashes that are conducted by manufacturers. While telecommuting, employees involved in this process have been reviewing documentation and video just as they would in the office. More than 30 such verification ratings have been completed since the facility shut down.

Still, the monthslong closure of the VRC has forced some changes to the Institute's plans for its ratings programs.

Before the pandemic, IIHS informed automakers that it was developing an evaluation of rear-passenger protection in frontal crashes, an updated side crash test and a seat-belt reminder rating. Those new tests were to be added to the Institute's awards criteria for 2022. Now the target year is 2023, and the *TOP SAFETY PICK* and *TOP SAFETY PICK+* criteria for 2022 will remain the same as for 2021 and 2020.

This additional time will also make it more realistic for automakers to achieve the higher standards. Manufacturers have seen pandemic-related disruptions to their supply chains and manufacturing, as well as to their own testing capabilities. ■

Insurance Institute for Highway Safety
Highway Loss Data Institute

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Status Report

IIHS is an independent, nonprofit scientific and educational organization dedicated to reducing the losses — deaths, injuries and property damage — from motor vehicle crashes.

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.

Both organizations are wholly supported by auto insurers and insurance associations.

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