Rear Crash Prevention Test Protocol

Version I

July 2024

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Contents

SUMMARY

This protocol describes the test procedure used to evaluate rear crash prevention systems on passenger vehicles similar to those that have been documented to help drivers avoid police-reported backing crashes (Cicchino, 2019). Rear crash prevention systems can include

- parking sensors that warn drivers if there are objects in the way when the vehicle is in reverse,
- rear cross-traffic alert that detects vehicles approaching from either side that may cross the path of the backing vehicle, and
- automatic emergency braking that may automatically brake to prevent a collision.

This protocol is available from the *Rear crash prevention* section of the Insurance Institute for Highway Safety (IIHS) website.

The procedure is based on a subset of scenarios from the RCAR Parking autonomous emergency braking test procedure (RCAR, 2023). The tests simulate vehicle-backing collisions with (1) another passenger-vehicle target and (2) a bollard representing a pole.

Ratings are based on the availability of rear parking sensors and rear cross-traffic alert and the test vehicle's ability to avoid or significantly reduce the impact speed in the tests.

TEST ENVIRONMENT

Surface

Tests are conducted on a dry asphalt surface without visible moisture. The surface is straight and flat, with a maximum 1% lateral slope for water management. The asphalt must be in good condition, free of potholes, bumps, and/or cracks that could cause the test vehicle to pitch or roll excessively.

Surroundings

During testing, no other vehicles, obstructions, or other objects may be within 3 m (9.8 ft) of the test target. Overhead signs, bridges, gantries, or other significant structures within the lane must be more than 5 m (16 ft) above the ground.

Ambient conditions

Testing is not conducted during periods of inclement weather. This includes, but is not limited to, rain, snow, hail, fog, smoke, and/or ash. Nighttime testing is conducted on the IIHS covered track and can take place during rain or snow as long as the track surface remains dry. The ambient air temperature must be between −6.7°C (20°F) and 37.8°C (100°F) during testing. Peak wind speeds must be below 10 m/s (22.4 mph) to minimize target and test vehicle disturbance.

TARGETS

Passenger-car target

The Soft Car 360 Guided Soft Target (GST) system produced by AB Dynamics is used as the stationary passenger-car target (https://www.abdynamics.com/en/products/track-testing/adas-targets/soft-car-360). The Soft Car 360, henceforth referred to as the Global Vehicle Target (GVT), is Revision F or later.

The GVT is mounted on a stationary stand with a Teflon sheet underneath for maneuverability (Figure 1). The GVT is equipped with a U.S.-specific license plate. The GVT must be assembled per manufacturer requirements prior to each test.

Figure 1

Passenger-car target (GVT Revision F or later)

Bollard target

The reverse AEB bollard target (Figure 2) produced by Moshon Data is used as the bollard target (https://www.moshondata.com/en/reverse-aeb).

The bollard is constructed of a PVC tube with an internal ballast. Its dimensions are 13 cm (diameter) by 95 cm (height). The bollard is painted black.

Figure 2

Bollard Target

TEST VEHICLE PREPARATION

General

Tests are undertaken using a new vehicle in the "as received" condition with accumulated mileage between 200 and 5,000 miles (322 and 8,047 km) indicated on the odometer. Before testing starts, ensure that:

- the tires are new, original equipment tires inflated to the manufacturer's recommended cold inflation pressure: if more than one recommendation is provided, the tires are inflated to the lightly loaded condition;
- the fuel tank is filled to at least 90% of capacity with the appropriate fuel and maintained to at least 75% capacity throughout the testing; and
- all other fluid reservoirs are filled to at least their minimum indicated levels.

Instrumentation

An instrumented test vehicle includes a driver and all required equipment during testing. Where possible, the equipment is placed on the passenger side of the vehicle. The vehicle test weight should not exceed the vehicle curb weight by more than 200 kg (441 lb).

Test vehicles are equipped with an Oxford Scientific RT inertial and GPS/Locata navigation system to measure and record speed, longitudinal and lateral acceleration, longitudinal and lateral position, yaw rate, and impact time. These data are sampled and recorded at a frequency of 100 Hz.

A Racelogic Video VBOX is used to overlay data obtained from the Oxford RT-Range onto video recorded at 30 FPS. One camera is positioned inside the test vehicle facing the rearview camera image. Another camera is placed on the rear of the vehicle to verify impact.

Table 1 lists the equipment used in the test vehicle.

Table 1

Test vehicle instrumentation

Measurement	Equipment
Speed	Oxford RT
Longitudinal and lateral acceleration	Oxford RT
Longitudinal and lateral position	Oxford RT
Impact time	Oxford RT
Impact verification	Racelogic VBOX

TESTING

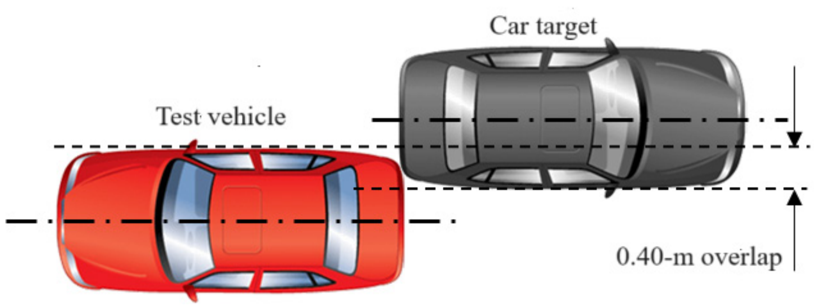
Testing consists of three vehicle-to-vehicle scenarios and one vehicle-to-bollard scenario.

Offset passenger car

At the point of impact, the longitudinal axes of the test vehicle and passenger-car target are parallel and the test vehicle overlaps 0.40 m with the car target, as shown in Figure 3. Test are conducted with the test vehicle backing straight back as well as backing from the left and from the right.

Figure 3

Offset passenger-car target impact location

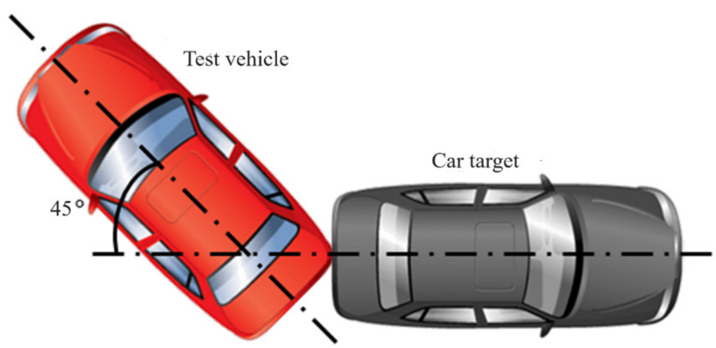


45-degree passenger car

At the point of impact, the longitudinal axis of the test vehicle is 45° to that of the passenger-car target and the rear corner of the test vehicle aligns with the rear center of the car target, as shown in Figure 4. Test are conducted with the test vehicle backing straight back as well as backing from the left and from the right.

Figure 4

45-degree passenger-car target impact location

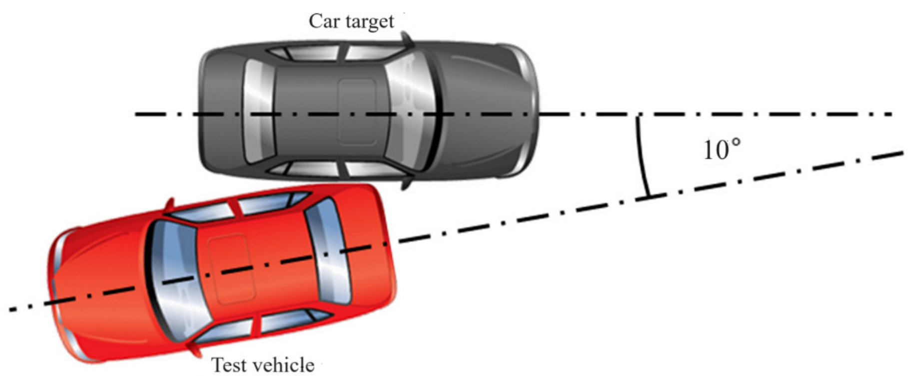


10-degree passenger car

At the point of impact, the longitudinal axis of the test vehicle is at 10° to the passenger-car target and the rear corner of the test vehicle aligns with the B-pillar of the car target, as shown in Figure 5. The test-vehicle impact point on the car target may not necessarily be the corner of the test vehicle as defined because of the vehicle geometry. Tests are only conducted with the vehicle backing straight.

Figure 5

10-degree passenger-car target impact location

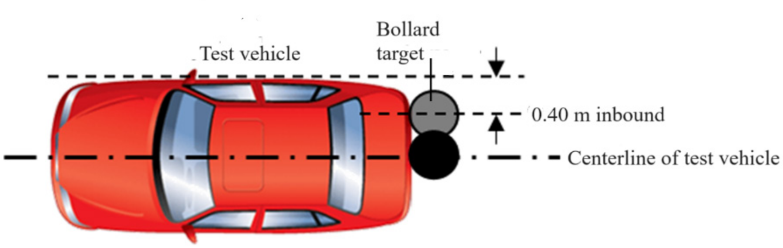


Offset bollard

At the point of impact, the centerline of the bollard is 0.40 m inbound from the side of the test vehicle, as shown in Figure 6. Tests are only conducted with the vehicle backing straight.

Figure 6

Offset bollard-impact location



Test trials

A total of three valid runs are performed in each test scenario.

Test vehicle speed

Tests are conducted at 6 ± 1 km/h.

Test vehicle approach

In all four scenarios, the test vehicle starts 6 m away from the target and is driven straight back (Figures 7 and 8). For the offset passenger car and 45 ° passenger tests, the test vehicle is driven straight back as well as from the left and from the right (Figure 8). In the left and right backing scenarios, the vehicle starts at a 90° angle from the impact position.

In the steering tests, vehicles do not necessarily track along the same path when traveling forward and reversing with the same steering input. To ensure the impact point is correct, the following procedure must be followed.

1. Align the rear of the vehicle at the impact point.
2. Holding the steering wheel in the maximum steering position, smoothly maneuver the test vehicle forwards until the vehicle is 90° from the impact point.
3. Maintaining the maximum steering wheel position, smoothly maneuver the test vehicle back to the impact point.
4. Determine the lateral offset between the current position of the vehicle and the original impact point.
5. Repeat the above process for a total of three runs for both maximum left steering and maximum right steering, respectively.
6. Calculate the average offset for left steering and right steering maneuvers. Apply it as necessary during testing to achieve the correct test configurations.

Figure 7

Offset bollard and 10-degree passenger-vehicle approaches

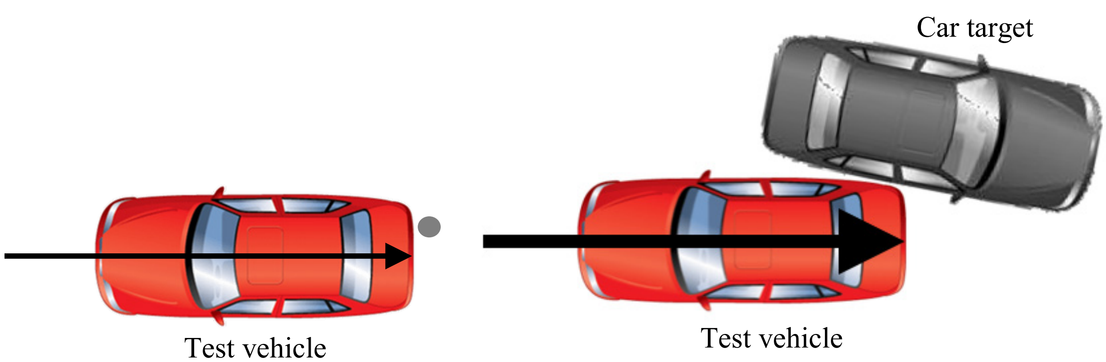
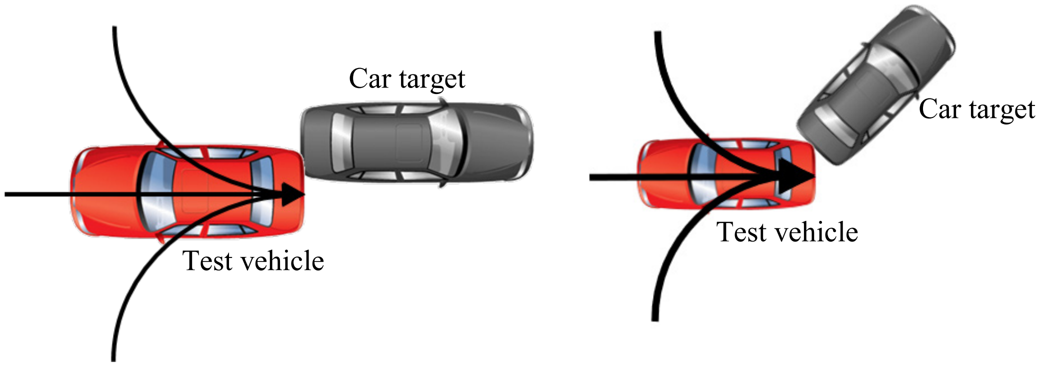


Figure 8
Offset passenger vehicle and 45-degree passenger-vehicle approaches



Impact point

The impact point is measured using the positioning system and is defined when and where the test vehicle first contacts the test target. A camera can be used to verify impact. Prior to each test scenario, a zero point is established with the test vehicle and target aligned and touching at the impact location.

DATA ANALYSIS

Lateral and longitudinal positions

The lateral and longitudinal positions are measured in meters, and raw data are used to evaluate the vehicle position.

Speed

The speed is measured in km/h. Raw data are used to evaluate speed.

Impact speed

The impact speed is measured from the GPS data when the vehicle position is 0 (impact point).

SCORING AND RATING SYSTEM

One point is awarded for every trial in which the vehicle completely avoids or mitigates the impact speed to less than 2 km/h. The weighting for each scenario is given in Table 1.

The number of trials the test vehicle completely avoids or mitigates the impact speed to less than 2 km/h is multiplied by the weighting factor to get the total number of points in that scenario. The maximum number of points available is 6. The final rating scale is shown in Table 2.

Table 1

Weighting for each scenario

Scenario	Steering Direction	Number of Trials	Weighting
Offset bollard	Straight	3	2/3
Offset passenger car	Straight	3	2/3
	Left	3	1/2
	Right	3	1/2
45° passenger car	Straight	3	2/3
	Left	3	1/2
	Right	3	1/2
10° passenger car	Straight	3	3/4
Rear cross-traffic alert (based on availability)	n/a	n/a	3/4
Warning (based on availability)	n/a	n/a	1/2

Note. n/a = not applicable.

Table 2

Final rating scale

Total score range	Rating	Rating icon
0.5 ≤ total score < 1.5	Basic	
1.5 ≤ total score < 4.5	Advanced	
4.5 ≤ total score < 6	Superior	

REFERENCES

Cicchino, J. B. (2019). Real-world effects of rear automatic braking and other backing assistance systems. *Journal of Safety Research*, *68*, 41–47. https://doi.org/10.1016/j.jsr.2018.12.005

RCAR. (2023, December). *Procedure for assessing the performance of Parking Autonomous Emergency Braking (P-AEB) systems in low speed maneuvering collisions* (Version 3). Available from: https://www.rcar.org/published-works