

**Bumper Test Protocol
(Version VII)**

June 2009

**INSURANCE INSTITUTE
FOR HIGHWAY SAFETY**

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Bumper Test Configurations

Four different bumper crash tests into a contoured, bumper-like barrier are conducted on each vehicle model. Front and rear full-overlap tests are conducted at 10 km/h, and front and rear corner tests are conducted at 5 km/h. The four tests were developed to promote compatible, stable, and energy-absorbing interfaces among vehicles in the fleet. The barrier heights for full-overlap and corner tests differ to simulate a broader range of impacts occurring in actual on-the-road crashes. Two vehicles are purchased to conduct the four tests.

Impact Barrier Specifications

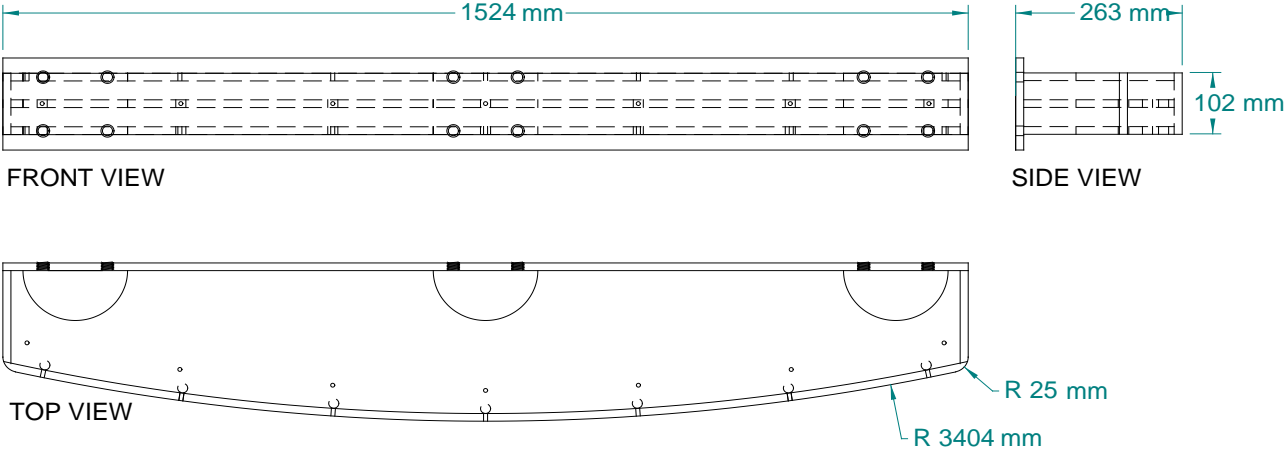
For all bumper tests, the impact barrier is 1,524 mm wide with a 3,404 mm radius and a flat 102 mm vertical surface (Figures 1, 3, 4, and 6). The barrier is constructed of 12.5 mm steel plate and mounted to a block of reinforced concrete weighing 145,150 kg. A steel backstop is mounted to the upper surface of the bumper barrier (Figures 2, 3, 4, and 6). The backstop also is constructed of 12.5 mm steel plate and is 1,524 mm wide with a 3,404 mm radius and a flat 200 mm vertical surface. The backstop is mounted with its center offset 25 mm rearward from the barrier face. Both the barrier face and backstop have a 25.4 mm radius incorporated into each end (Figure 7).

A plastic energy absorber is affixed to the impact area of the barrier face (Figure 4) with nylon push-pin rivets (Figure 5, McMaster-Carr Part #90221A119). Similarly, an overlying plastic cover is mounted to the barrier through slots along its upper and lower flanges (Figures 5 and 6). The energy absorber and cover are provided by NetShape Corporation and have a 152 mm radius from top to bottom. The energy absorber measures 1,524 mm long, 102 mm tall, and 51 mm deep.

For front and rear full-overlap tests, the impact barrier is mounted such that the forwardmost portion of the bottom edge of the barrier is 457 mm from the floor. At impact, the vehicle centerline is aligned with the barrier centerline.

For front and rear corner tests, the impact barrier is mounted such that the forwardmost portion of the bottom edge of the barrier is 406 mm from the floor. At impact, the vehicle overlaps the lateral edge of the barrier by 15 percent of the vehicle's width as measured at the wheel wells (including moldings and sheet metal protrusions) at the corresponding axle — front axle for front corner tests (Figure 8) and rear axle for rear corner tests.

**Figure 1
Contoured Steel Bumper Barrier**



**Figure 2
Contoured Steel Backstop**

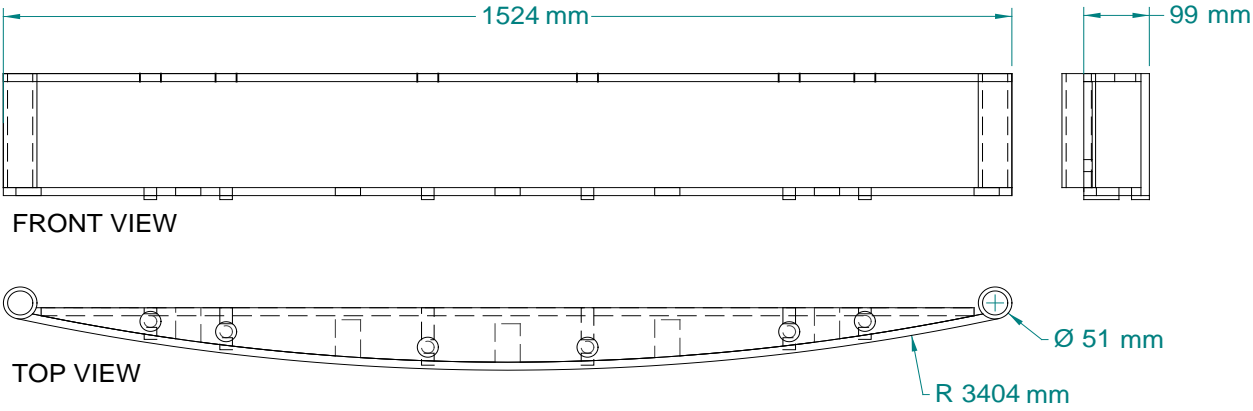


Figure 3
Bumper Barrier and Backstop



Figure 4
Plastic Energy Absorber Mounted on Bumper Barrier



Figure 5
Nylon Push-Pin Rivet Fasteners
(McMaster-Carr Part #90221A119)



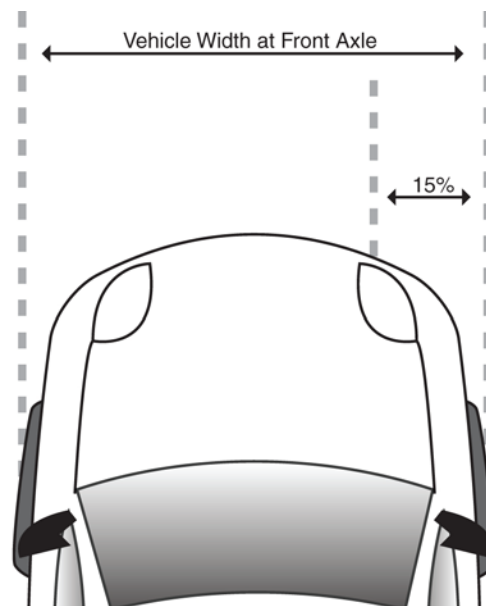
Figure 6
Plastic Energy Absorber and Cover Mounted on Bumper Barrier



Figure 7
Barrier and Backstop with Rounded Corners



Figure 8
Front Corner Tests – 15 Percent Overlap Based on
Vehicle Width at Front Axle Measured at Wheel Wells



Test Vehicle Preparation

Each vehicle is inspected upon arrival at the Vehicle Research Center and is checked for evidence of prior collision damage or repair. Each vehicle is further examined to verify that it is in satisfactory operating condition and to note defects such as missing parts, maladjustments, or fluid leaks. If judged directly relevant to testing, such deficiencies are corrected or a replacement vehicle is procured.

Tires are inflated to the manufacturer's recommended 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 percent of capacity with the appropriate fuel. All other fluid reservoirs are filled to at least their minimum indicated levels. The front and rear license plate brackets (if provided) and all associated fasteners are removed. Bolt-on trailer hitch reinforcement members that are supplied as optional equipment are removed, but their fasteners are reattached to the vehicle where possible.

Prior to placement of any instrumentation or ballast weight, each vehicle is weighed to determine its curb weight. Test weight includes a ballast weight of 77.1 kg in the driver seat and 10.5 kg of instrumentation located in the front or rear passenger seat. The instrumentation and ballast weight are secured in the vehicle using the vehicle's seat belts.

The vehicle hood is closed. The trunk lid, liftgate, or tailgate is closed and not locked (if it can be closed without locking). The spare tire, jack, tools, and other equipment are secured with the manufacturer-supplied fasteners. Doors are closed but not locked, and all side windows are fully

open. All rear seats (if removable) are left in place and unfolded (if foldable) or latched to accept occupants. Integrated child seats (if present) are stowed. All lights (except daytime running lights), wipers, and climate control and sound systems are turned off. The vehicle's ignition switch is turned to its on position, but the engine is not started. The transmission is shifted into its neutral position, and the parking brake is fully released.

A propulsion system is used to propel the vehicle toward the barrier. Each vehicle is attached to a cable driven by the propulsion system. The vehicle is released from the propulsion system no more than 300 mm before impact. This allows the vehicle to travel under its own momentum at speed into the barrier at its normal running attitude.

Impact Speed Measurement

Impact speed is measured using an optical speed sensor mounted on the side of the vehicle and aimed downward to detect reflective tape strips on the crash hall floor. The leading edges of the strips are spaced 456 mm apart. Thus the impact speed recorded is the average speed over the 456 mm length of vehicle travel, which ends approximately 150 mm before the vehicle's impact with the barrier. The speed sensor is connected to its own battery-powered timing module located inside the vehicle that displays the vehicle's speed in kilometers per hour.

The propulsion system also has an optical speed measuring device that serves as a backup to the speed sensor onboard the vehicle. The device measures the speed of the hardware attaching the vehicle to the propulsion system immediately prior to the vehicle's release from the propulsion system. The speed is clocked over a 1,000 mm length of vehicle travel ending 500 mm before the vehicle's release.

Photography

Tests are recorded with a minimum of one overhead and one floor-mounted digital imager (500 frames per second) or film camera (125 frames per second) and a floor-mounted real-time Sony Betacam video camera (30 frames per second). Following the completion of each test, the vehicle is photographed with a digital still camera to document any resulting damage. Additional close-up photographs are taken of readily visible damage at that time; photographs also are taken during the teardown/appraisal process to document hidden damage.

Damage Estimates

The damage estimating process is conducted as it would be done in a repair shop; each bumper assembly is generally removed and dismantled to check for possible hidden damage. Damage repair estimates are conducted using industry standard appraisal techniques and documented in a computerized system developed by Audatex, a Solera company.

For hourly labor rates indicated in the estimates, Audatex supplies an average of labor rates for body repair and refinishing used in actual estimates by its clients across the country as of the most recent calendar year quarter. This average rate is rounded to the nearest dollar and used in calculating labor costs. Similarly, the cost for paint and related materials is based on the average

rate used by Audatex clients during the most recent quarter (rounded to the nearest dollar) and is directly proportional to the total refinishing time for each estimate.

For part replacement indicated in the estimates, new original equipment replacement parts at full list prices are specified (based primarily on the most recent Audatex information, but secondarily on data from the appropriate *Mitchell Collision Estimating Guide*, *Motor Crash Estimating Guide* or vehicle manufacturers or dealers). No discounts, betterments, appearance allowances, insurance deductibles, taxes, or vehicle storage fees are applied. If a vehicle has clear coat (two-stage clear over color) paint, all estimates requiring refinishing include the appropriate additional labor time (in most cases automatically computed by the Audatex system, otherwise manually calculated by the appraisers).

Ratings

Upon completion of the damage estimating process, each vehicle is given a rating of good, acceptable, marginal, or poor based on its weighted test result. The weighted test result is determined by multiplying the front full and rear full test damage estimates by two (because full-width impacts occur approximately twice as often as corner impacts in the real world) and then adding that total to the front corner and rear corner test damage estimates. The sum then is divided by six to obtain the weighted average, and this number determines the overall rating. The good/acceptable boundary is \$500, the acceptable/marginal boundary is \$1,000, and the marginal/poor boundary is \$1,500. However, no vehicle can earn a rating of good or acceptable if the vehicle is deemed undrivable or unsafe after a test because of severe headlamp or taillamp damage, hood buckling, coolant loss, or the like.