

6. Relevant safety standards in North America and Europe

North American and European safety standards for vehicles are summarized in Table 6.1. While most of the standards in Table 6.1 are enacted by legislation, several of the standards, where so indicated, are voluntarily set by the OEM's.

The North American bumper performance standards are more severe than the European ones. Thus, the bumpers on North American vehicles are considerably stronger than those on European vehicles. Although the North American bumper standards are set by legislation at the 2.5 mph (4 km/h) level for passenger cars, the North American OEM's voluntarily use a 5 mph (8 km/h) performance standard for passenger cars. At this impact speed, there must be no visual damage on a vehicle and there must be no damage to any safety items. However, damage to hidden components of the bumper system is acceptable.

Currently, there are no bumper performance standards for light trucks. Most North American OEM's use the voluntary 5 mph (8 km/h) passenger car standard for their minivans. In general, the OEM's use a voluntary 2.5 mph (4 km/h) performance standard for the remainder of the light truck category (full size vans, pickups and sport utilities). At this impact speed, there must be no visual damage on a vehicle and there must be no damage to any safety items. However, damage to hidden components of the bumper system is acceptable.

Europe has a greater concern about bumper repair cost than North American. Hence, the European insurance industry uses a 9 mph (15 km/h) test (known as the Thatcham test in England and the Danner test in Germany) to evaluate repair costs. This test establishes insurance collision premiums for the first year of a new model introduction. In North America, the Insurance Institute for Highway Safety (IIHS) uses four tests at 5 mph (8 km/h). Europe attaches more importance to the ease of bumper replacement compared to North American. Thus, the European insurance industry grants a credit, which is based on ease of replacement. This credit is applied to the bumper repair cost. As a result, European bumper designers strive to obtain ease of replacement. For example, they may use bolts, rather than weldments, to facilitate ease of repair.

In current North American practice, the governing design condition for a bumper system is the 2.5 or 5 mph (4 or 8 km/h) low-speed impact requirement. Current bumper systems are not designed to absorb energy under high-speed impact. However, systems are being developed that can absorb about 15% of the energy under high-speed impact.

TABLE 6.1

RELEVANT SAFETY STANDARDS IN NORTH AMERICA AND EUROPE

NORTH AMERICA	EUROPE	KEY DIFFERENCES
<p>Bumper Performance</p> <ul style="list-style-type: none"> U.S. standard for passenger cars calls for no visual damage and no damage to safety items at 2.5 mph (4 km/h); Canada calls for limited damage at 5 mph (8 km/h) for passenger cars. Automakers have combined the more stringent aspects of each standard - no visual damage and no damage to safety items at 5 mph (8 km/h) for passenger cars. 	<p>Bumper Performance</p> <ul style="list-style-type: none"> No requirement standard, but most countries follow ECE 42, which calls for no serious damage (light bulbs may be changed) at 2.5 mph (4 km/h). 	<ul style="list-style-type: none"> 5 mph vs. 2.5 mph (8 km/h vs. 4 km/h). Law vs. recommendation Greater damage allowed in Europe.
<p>Insurance Testing</p> <ul style="list-style-type: none"> The IIHS (Insurance Institute for Highway Safety) conducts 4 tests at 5 mph (8 km/h) which measures repair costs for the bumper. The tests are front into barrier, rear into barrier, front into angle barrier and rear into pole. Statistics are published in a newsletter. 	<p>Insurance Testing</p> <ul style="list-style-type: none"> European insurance agencies have a test that measures costs for bumper repair (a credit is given for ease of replacement). The test is a 9 mph (15 km/h) impact at a 40 percent offset. In England, it's called the Thatcham Test, in Germany, it's called the Danner Test. 	<ul style="list-style-type: none"> 5 mph vs. 9 mph (8 km/h vs. 15 km/h). Europe gives credit for ease of replacement.
<p>High-Speed Crash Tests CFR 571.208 Occupant Crash Protection</p> <ul style="list-style-type: none"> Frontal rigid barrier collision applies to passenger cars, MPVs, trucks and buses. 30 mph (48 km/h) frontal collision. No separation of any load bearing element of a seatbelt assembly or anchorage. Lateral collision 20 mph (32 km/h) and impact both sides. FMVSS 301, combination of 30 mph (48 km/h) frontal/rear and 20 mph (32 km/h) side. 	<p>High-Speed Crash Tests</p> <ul style="list-style-type: none"> 40% offset driver's side Front-end collision 35 mph (56 km/h) Deformable barrier/honeycomb aluminum structure (proposed) ECE 33 head-on collision unladen vehicle hits barrier at 30 - 33 mph (48 - 53 km/h) ECE 32 rear-end collision impact or pendulum 22 - 24 mph (35 - 38 km/h) 	<ul style="list-style-type: none"> Rigid vs. deformable barrier. Head-on vs. offset collision.
	<p>Pedestrian Safety Proposal</p> <ul style="list-style-type: none"> ECE 222 Proposal (2001). 25 mph (40 km/h). Knee angle limited to 15°. Thigh (hip) into hood. 	

There is a degree of speculation that the 2.5 mph (4 km/h) voluntary design standard used by the North American OEM's for full size vans, pickups and sport utilities might rise to 5 mph (8 km/h). If this change were to occur, then the bumper systems on these vehicles would require a redesign. Such a redesign would likely mean the facebar systems commonly used on these vehicles would revert to reinforcing beam systems.

A pedestrian safety standard currently being proposed in Europe is shown in Table 6.1. If enacted, this standard would have an effect on front-end styling and, in turn, bumper system design.

6.1 United States National Highway Traffic Safety Administration (49CFR), Part 581, Bumper Standard

This standard is summarized in Sections 6.1.1 through 6.1.4. The reader is cautioned that these sections are only a summary. The reader must refer to the actual regulatory document in order to obtain a complete understanding of the standard.

6.1.1 Requirements

The Bumper Standard only applies to passenger vehicles. A manufacturer may apply for an exemption of a special use passenger vehicle if compliance with the standard would reasonably interfere with the special use of the vehicle. For example, a shuttle vehicle used within the confines of a retirement complex.

A passenger vehicle is subjected to three impact procedures:

1. The pendulum corner impacts - front and rear.
2. The pendulum longitudinal impacts - front and rear.
3. The impacts into a fixed collision barrier - front and rear.

Following the three impact procedures, the vehicle shall meet the following damage criteria:

1. Each lamp or reflective device except license plate lamps shall be free of cracks and shall comply with applicable visibility requirements. The aim of each headlamp shall be adjustable to within the beam aim inspection limits.
2. The vehicle's hood, trunk and doors shall operate in the normal manner.
3. The vehicle's fuel and cooling systems shall have no leaks or constricted fluid passages and all sealing devices and caps shall operate in the normal manner.
4. The vehicle's exhaust system shall have no leaks or constrictions.
5. The vehicle's propulsion, suspension, steering and braking systems shall remain in adjustment and shall operate in the normal manner.
6. A pressure vessel used to absorb impact energy in an exterior protection system by the accumulation of gas or hydraulic pressure shall not suffer loss of gas or fluid accompanied by separation of fragments from the vessel.

7. The vehicle shall not touch the test device, except on the impact ridge shown in Figures 6.1 and 6.2, with a force that exceeds 2000 pounds (907 kg) on the combined surfaces of Planes A and B (see Figure 6.3) of the test device.
8. The exterior surfaces shall have no separations of surface materials, paint, polymeric coatings, or other covering materials from the surface to which they are bonded, and no permanent deviations from their original contours 30 minutes after completion of each pendulum and barrier impact, except where such damage occurs to the bumper face bar and the components and associated fasteners that directly attach the bumper face bar to the chassis frame.
9. Except as provided in Criterion 8 (above), there shall be no breakage or release of fasteners of joints.

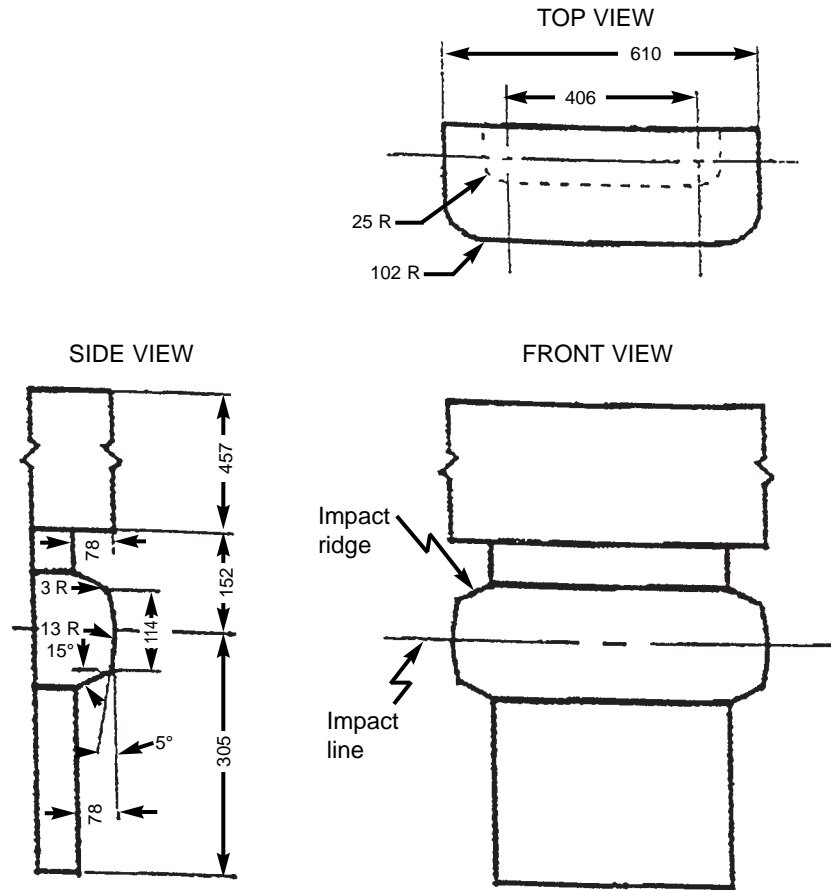
6.1.2 Pendulum corner impacts

1. See Figure 6.4.
2. Impact speed of 1.5 mph (2.4 km/h).
3. Impact one front corner at a height of 20 inches (500 mm) using Figure 6.1 pendulum.
4. Impact other front corner at a height from 16 to 20 inches (400 to 500 mm) using Figure 6.2 pendulum.
5. Impact one rear corner at a height of 20 inches (500 mm) using Figure 6.1 pendulum.
6. Impact other rear corner at a height from 16 to 20 inches (400 to 500 mm) using Figure 6.2 pendulum.
7. The plane containing the pendulum swing shall have a 60 degree angle with the longitudinal plane of the vehicle.
8. Impacts must be performed at intervals not less than 30 minutes.
9. Effective impacting mass of pendulum equals mass of vehicle.
10. Trailer hitches, license plate brackets, and headlamp washers are removed. Running lights, fog lamps and equipment mounted on the bumper face bar are removed if they are optional equipment.

6.1.3 Pendulum longitudinal impacts

1. See Figure 6.4.
2. Impact speed of 2.5 mph (4 km/h).
3. Two impacts on front surface, inboard of corner.
4. Two impacts on rear surface, inboard of corner.
5. Impact line may be any height from 16 to 20 inches (400 to 500 mm). If height is 20 inches (500 mm), use Figure 6.1 pendulum. If height is between 20 and 16 inches (500 and 400 mm), use Figure 6.2 pendulum.
6. Pendulum Plane A (see Figure 6.3) is perpendicular to the longitudinal plane of the vehicle.
7. For each impact, the impact line must be at least 2 inches (50 mm) in the vertical direction from its position in any prior impact, unless the midpoint of the impact line is more than 12 inches (300 mm) apart laterally from any prior impact.
8. Impacts must be performed at intervals not less than 30 minutes apart.
9. Effective impacting mass of pendulum equals mass of vehicle.
10. Trailer hitches, license plate brackets, and headlamp washers are removed. Running lights, fog lamps and equipment mounted on the bumper face bar are removed if they are optional equipment.

**FIGURE 6.1
IMPACT PENDULUM**



NOTES:

1. Dimensions in mm
2. Not to scale

UNITED STATES REGULATIONS:

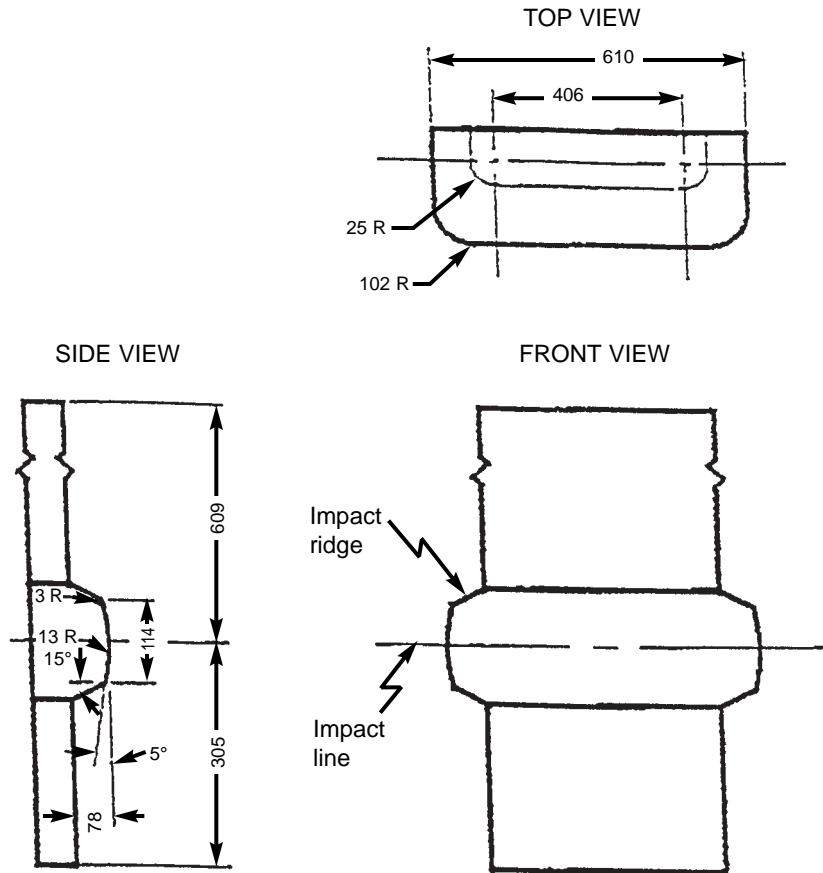
- a) Longitudinal impact if height is 20 inches (500 mm).
- b) One front and one rear corner impact at a height of 20 inches (500 mm).

CANADIAN REGULATIONS:

- a) One front and one rear corner impact at a height of 500 mm (20 inches).

Source: Canada: Motor Vehicle Safety Regulations, Standard 215, 1978

**FIGURE 6.2
IMPACT PENDULUM**



NOTES:

1. Dimensions in mm
2. Not to scale

UNITED STATES REGULATIONS:

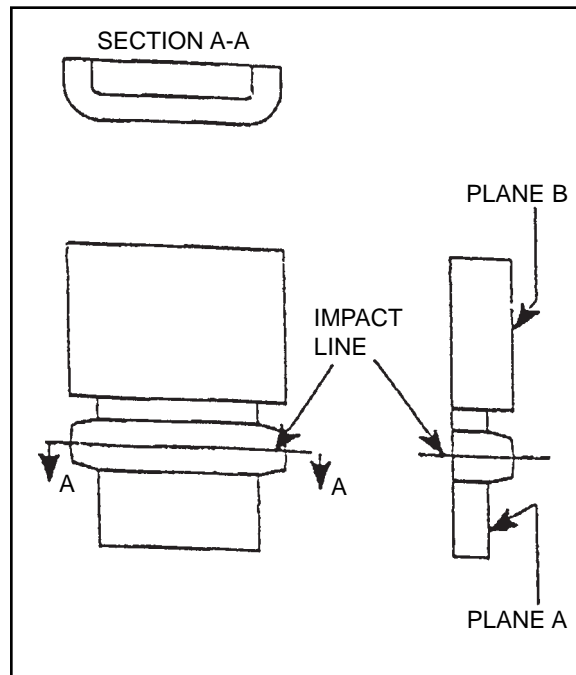
- a) Longitudinal impact if height is between 20 and 16 inches (500 mm and 400 mm).
- b) One front and one rear corner impact at a height from 16 to 20 inches (400 to 500 mm).

CANADIAN REGULATIONS:

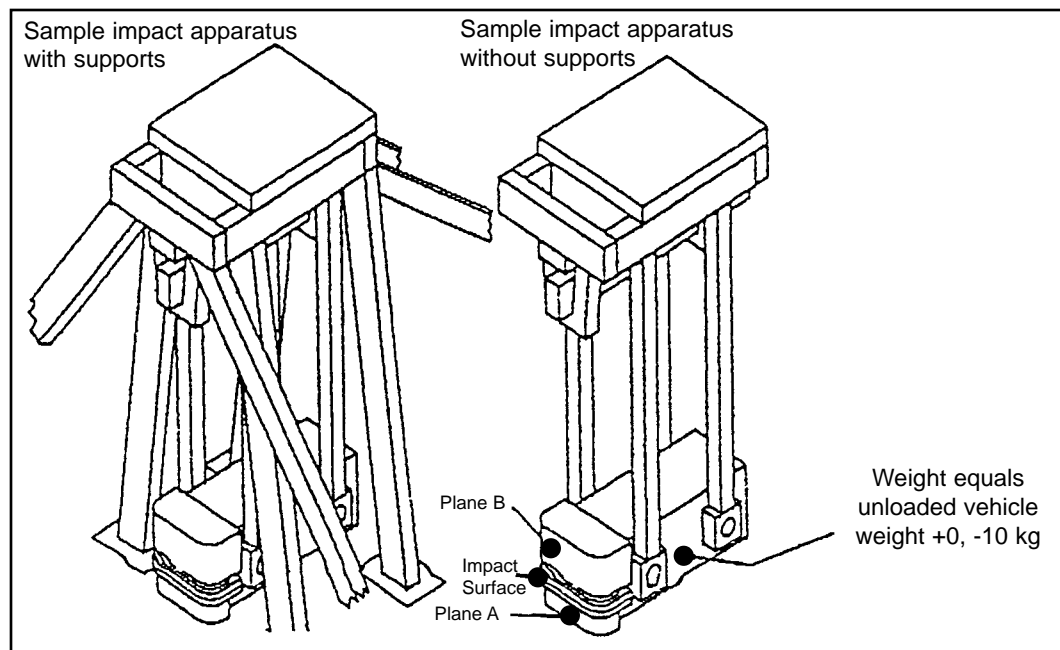
- a) Longitudinal impact at height from 500 to 400 mm (20 to 16 inches).

Source: Canada: Motor Vehicle Safety Regulations, Standard 215, 1978

**FIGURE 6.3
LOCATIONS OF PLANES A and B**



**FIGURE 6.4
SAMPLE IMPACT APPARATUS**



NOTES:

1. Drawing not to scale.
2. The arc described by any point on impact line shall be constant with a minimum radius of 3.3 m and lie in a plane perpendicular to Plane A.

Source: Transport Canada, Safety and Security

6.1.4 Impacts into a fixed collision barrier

1. Impact speed of 2.5 mph (4 km/h).
2. Impact into a fixed collision barrier perpendicular to line of travel while travelling longitudinally forward.
3. Impact into a fixed collision barrier perpendicular to line of travel while travelling longitudinally rearward.
4. Trailer hitches, license plate brackets, and headlamp washers are removed. Running lights, fog lamps and equipment mounted on the bumper face bar are removed if they are optional equipment.

6.2 Canadian Motor Vehicle Safety Regulations Standard 215

This standard is summarized in Sections 6.2.1 through 6.2.4. The reader is cautioned that these sections are only a summary. The reader must refer to the actual regulatory document in order to obtain a complete understanding of the standard.

6.2.1 Requirements

A passenger vehicle is subjected to three impact procedures:

1. The pendulum corner impacts - front and rear.
2. The pendulum longitudinal impacts - front and rear.
3. The impacts into a fixed collision barrier - front and rear.

Following the three impact procedures, the vehicle shall meet the following damage criteria:

1. Each lamp or reflective device except license plate lamps shall be free of cracks and shall comply with applicable visibility requirements. The aim of each headlamp shall be adjustable to within the beam aim inspection limits.
2. The vehicle's hood, trunk and doors shall operate in the normal manner.
3. The vehicle's fuel and cooling systems shall have no leaks or constricted fluid passages and all sealing devices and caps shall operate in the normal manner.
4. The vehicle's exhaust system shall have no leaks or constrictions.
5. The vehicle's propulsion, suspension, steering and braking systems shall remain in adjustment and shall operate in the normal manner.

6.2.2 Pendulum corner impacts

1. See Figure 6.4.
2. Impact speed of 4.8 km/h (3.0 mph).
3. Impact one front corner at a height of 500 mm (20 inches) using Figure 6.1 pendulum.
4. Impact one rear corner at a height of 500 mm (20 inches) using Figure 6.1 pendulum.
5. The plane containing the pendulum swing shall have a 60 degree angle with the longitudinal plane of the vehicle.
6. Impacts must be performed at intervals not less than 30 minutes apart.
7. Effective impacting mass of pendulum equals mass of vehicle.
8. Trailer hitches and license plate brackets are removed.

6.2.3 Pendulum longitudinal impacts

1. See Figure 6.4.
2. Impact speed of 8 km/h (5 mph).
3. Two impacts on front surface using Figure 6.2 pendulum, inboard of corner.
4. Two impacts on rear surface using Figure 6.2 pendulum, inboard of corner.
5. Impact line may be any height from 500 mm to 400 mm (16 to 20 inches).
6. Pendulum Plane A is perpendicular to the longitudinal plane of the vehicle.
7. For each impact, the impact line must be at least 50 mm (2 inches) in the vertical direction from its position in any prior impact, unless the midpoint of the impact line is more than 300 mm (12 inches) apart laterally from any prior impact.
8. Impacts must be performed at intervals not less than 30 minutes apart.
9. Effective impacting mass of pendulum equals mass of vehicle.
10. Trailer hitches and license plate brackets are removed.

6.2.4 Impacts into a fixed collision barrier

1. Impact speed of 8 km/h (5.0 mph).
2. Impact into a fixed collision barrier perpendicular to line of travel while travelling longitudinally forward.
3. Impact into a fixed collision barrier perpendicular to line of travel while travelling longitudinally rearward.
4. Trailer hitches and license plate brackets are removed.

6.3 Comparison between United States and Canadian Bumper Regulations

The reader is cautioned that the comparison in Sections 6.3.1 through 6.3.4 is only a summary. The reader must refer to the actual regulatory documents in order to obtain a complete comparison.

The United States and Canada use the same test apparatus. The United States permits running lamps, fog lamps and equipment on the bumper face bar to be removed if they are optional, while Canada does not. The United States uses lower test speeds than Canada. As a generalization, the United States requires no visual damage to all non-bumper parts, while Canada requires no damage to safety and functional items.

6.3.1 Requirements

The United States, but not Canada, has the following requirements:

1. A pressure vessel used to absorb impact energy in an exterior protection system by the accumulation of gas or hydraulic pressure shall not suffer loss of gas or fluid accompanied by separation of fragments from the vessel.
2. The vehicle shall not touch the test device, except on the impact ridge shown in Figures 6.1 and 6.2, with a force that exceeds 2000 pounds (907 kg) on the combined surfaces of Planes A and B (see Figure 6.3) of the test device.
3. The exterior surfaces shall have no separations of surface materials, paint, polymeric coatings, or other covering materials from the surface to which they are bonded, and no permanent deviations from their original contours 30 minutes after completion of each pendulum and barrier impact, except where such damage occurs to the bumper face bar and the components and associated fasteners that directly attach the bumper face bar to the chassis frame.
4. Except as provided in Criterion 8 of Section 6.1.1, there shall be no breakage or release of fasteners of joints.

6.3.2 Pendulum corner impacts

1. The United States has an impact speed of 1.5 mph (2.4 km/h), Canada 4.8 km/h (3.0 mph).
2. Both the United States and Canada require a front and a rear corner be tested using the Figure 6.1 pendulum. Only the United States requires that the other front and other rear corner be tested (The Figure 6.2 pendulum must be used.).

6.3.3 Pendulum longitudinal impacts

1. The United States has an impact speed of 2.5 mph (4 km/h), Canada (5.0 mph).

6.3.4 Impacts into a fixed collision barrier

1. The United States has an impact speed of 2.5 mph (4 km/h), Canada 8 km/h (5.0 mph).

6.4 Insurance Institute for Highway Safety: Low-Speed Crash Test Protocol (Reference 6.8)

This protocol is summarized in Sections 6.4.1 through 6.4.6. The reader is cautioned that these sections are only a summary. The reader must refer to the actual protocol document in order to obtain a complete understanding of the protocol.

6.4.1 Requirements

Following each of four tests (front into full-width flat-barrier, rear into full-width flat-barrier, right front into 30 degree angle-barrier and rear into pole), IIHS writes a damage estimate. Minor cosmetic damage to the exterior bumper surface is excluded, even if there is significant damage to other bumper parts. Although IIHS would like to see a zero damage estimate, there is no criteria for an acceptable or an unacceptable damage estimate.

6.4.2 Test vehicles

1. One vehicle is used for the front into full-width flat-barrier and rear into pole impacts. A second vehicle is used for the right front into 30 degree angle-barrier and rear into full-width flat-barrier impacts.
2. Front and rear license plates, front license plate bracket (if provided), and all associated fasteners are removed. The rear license plate bracket (if present) is left in place unless it is bolted or riveted directly to the external face of the rear bumper, in which case both the bracket and 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.

6.4.3 Full-width flat-barrier impact

1. Two tests - front into barrier and rear into barrier.
2. Impact speed of 5 mph (8 km/h).
3. The barrier is a 145.15t (160 tons) block of reinforced concrete, faced with a steel plate 8.0 cm (3 inches) thick. The impact area on the steel plate is covered with 2 cm (0.75 inches) thick plywood.
4. The barrier is perpendicular to the vehicle's line of travel (forward or rearward).

6.4.4 Right front into 30 degree angle-barrier impact

1. Impact speed of 5 mph (8 km/h).
2. A rigid steel fixture is bolted to the floor. It includes a steel plate 214 cm (84 inches) wide, 92 cm (36 inches) high and 4.5 cm (1.75 inches) thick. The steel plate is covered with 2 cm (0.75 inches) thick plywood. The bottom edges of the steel plate and plywood are 18 cm (7 inches) above the floor level. Thus, the top edges are 110 cm (43 inches) above floor level. The angle between the longitudinal centerline of the vehicle and the plane of the plywood is 60 degrees (90 minus 30 degrees).

6.4.5 Rear into pole impact

1. Impact speed of 5 mph (8 km/h).
2. Steel pole is 18 cm (7 inches) in diameter and extends 92 cm (36 inches) above the floor.
3. Normally, the longitudinal centerline of vehicle is aligned with the pole and becomes the target point. However, if some aspect of the bumper design (e.g., a trailer hitch) prevents a general assessment of the bumper's performance, the longitudinal centerline is moved left or right of the pole. The target point is the midpoint of the span from the vehicle centerline to the inboard edge of the rear frame sidemember end.
4. The actual impact point on the bumper will not be more than 7.5 cm (3 inches) either side of the target point.

6.5 Consumers Union bumper-basher tests (Reference 6.9)

These tests are summarized in Sections 6.5.1 through 6.5.5. The reader is cautioned that these sections are only a summary. The reader must refer to actual test documents in order to obtain a complete understanding of the tests.

6.5.1 Requirements

The front and the rear bumper of a vehicle are each impacted three times – at the center, off-center and at a corner. Following the three tests on a front or rear bumper, the total cost for parts and labor to repair the damage to the body and bumper is estimated. Minor cosmetic damage to the exterior bumper surface is usually ignored if no other problems are found. Consumers Union does not use bumper repair cost as a Ratings factor. However, it does publish the repair cost for the front bumper, the rear bumper and the total for both bumpers in *Consumer Reports* magazine.

6.5.2 Bumper-basher

Consumers Union uses an impact bar similar to that shown in Figure 6.2 for all impacts. However, it is not swung as a pendulum. Rather, it is hydraulically propelled, like a battering ram, in the horizontal direction. Weights, equal to the weight of the vehicle, are placed on the ram.

6.5.3 Center impact

1. The front bumper is impacted at a height of 20 inches (500 mm) and the rear bumper at a height of 16 inches (400 mm). An impact bar similar to that shown in Figure 6.2 is used for both impacts.
2. 5 mph (8 km/h) impact at vehicle centerline.

6.5.4 Off-center impact

1. The front bumper is impacted on the driver's side at a height of 20 inches (500 mm). The rear bumper is impacted on the passenger's side at a height of 16 inches (400 mm). An impact bar similar to that shown in Figure 6.2 is used for both impacts.
2. 5 mph (8 km/h) impact with outside edge of impact bar at outboard surface of the body (fender/front bumper cover or quarter panel/rear bumper cover). Thus, the impact point is usually about midway between the vehicle centerline and the outboard surface of the vehicle.

6.5.5 Corner impact

1. The front bumper is impacted on the driver's side at a height of 20 inches (500 mm). The rear bumper is impacted on the passenger's side at a height of 16 inches (400 mm). An impact bar similar to that shown in Figure 6.2 is used for both impacts.
2. 3 mph (4.8 km/h) impact at 30 degrees on the corner.

6.6 Research Council for Automotive Repairs (RCAR) Low-Speed Offset Crash Test (Reference 6.10)

This test is summarized in Sections 6.6.1 through 6.6.5. The reader is cautioned that these sections are only a summary. The reader must refer to the actual test document in order to obtain a complete understanding of the test.

RCAR states its standard insurance test reflects the typical low-speed impact, and provides the average level of damage, insurers are paying for every day.

6.6.1 Requirements

Two impacts are conducted. The first is a 15 km/h (9 mph) impact by the front of the test vehicle into a fixed barrier with a 40% offset. The second is a 15 km/h (9 mph) impact by a mobile barrier, with a 40% offset, into the rear of the test vehicle. After each impact, the replacement parts required to reinstate the vehicle to its pre-accident condition are recorded. Also, the number of hours required to replace the damaged parts and to repair those items capable of repair, such that the vehicle is reinstated to the pre-accident condition are recorded. The cost of the replacement parts and the number of hours are estimated. Thus, the results of the crash test indicate the reparability and damageability status of the test vehicle.

6.6.2 Test vehicle

The test vehicle is previously undamaged and representative of the series production. The test vehicle for the rear impact may be the same vehicle used for the front impact, provided the damage sustained during the front impact has no effect on the results of the rear impact.

6.6.3 Front impact

1. One impact into a non-deformable barrier/former (see Figure 6.5). The former can be adjusted laterally to accommodate various vehicle widths. The former may be secured to a fixed barrier or placed on the ground with arresting devices to restrict its movement. The front face of the former is perpendicular to the direction of travel of the test vehicle. The mass of the barrier/former exceeds twice that of the test vehicle. The steering column side of the vehicle contacts the former. The test vehicle overlaps the former by 40%.
2. The test vehicle impact speed is 15 km/h (9 mph).

6.6.4 Rear impact

1. One impact by a mobile barrier into the test vehicle (Figure 6.6). The mobile barrier has a mass of 1000 kg (2205 pounds).
2. The mobile barrier contacts the side of the vehicle opposite to the steering column side. The barrier overlaps the test vehicle by 40%. The barrier impact speed is 15 km/h (9 mph).

6.6.5 Damageability and repairability

RCAR's objective is "to improve the level of safety, security, quality, design and method of repair of motor vehicles in order to reduce costs to the insurance industry and to the motoring public". To this end, RCAR has prepared a Design Guide (Reference 6.11) aimed at reducing the damageability and repairability cost incurred in low-speed impacts.

Damageability is the measure of a vehicle's ability to withstand the forces of a low-speed impact. It denotes which body structure and other components are damaged as a result of the impact.

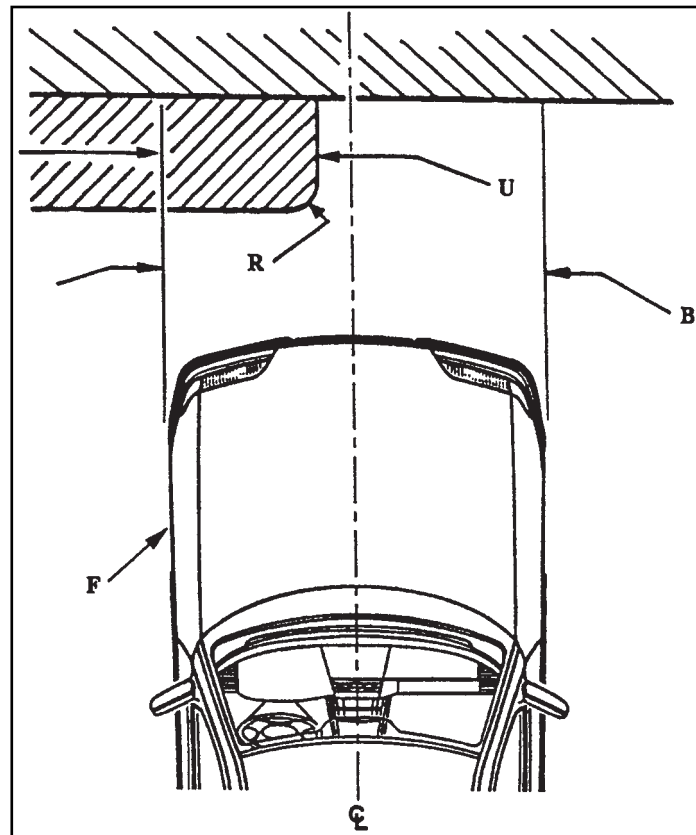
Repairability measures how easily, quickly and cost-effectively the damaged structure and components can be repaired or replaced.

The RCAR Design Guide lists optimum damageability and repairability features of a bumper system as:

1. The system plays an important role in energy management during vehicle accidents.
2. The system withstands impacts up to 15 km/h (9 mph) without initiating damage to the body structure beyond the body mounting system.
3. The main bumper mountings are capable of transmitting impact forces into the rails for maximum energy absorption. They are not an integral part of the bumper, but separate items that can be replaced easily in the event of damage.
4. Any side mountings are of the quick-release type.
5. Bumper covers are thermoplastic. Hot air welding or adhesives may repair them.
6. Wrap-around bumpers afford much greater protection during minor parking incidents.

FIGURE 6.5 RCAR FRONT CRASH PROCEDURE

The height of the barrier shall exceed the height of the front of the test vehicle.
The test vehicle shall be free of any additional or propelling device at the moment of impact.
Test Vehicle Mass: Net curb weight +75 kg for driver and a full fuel tank or equivalent ballast.



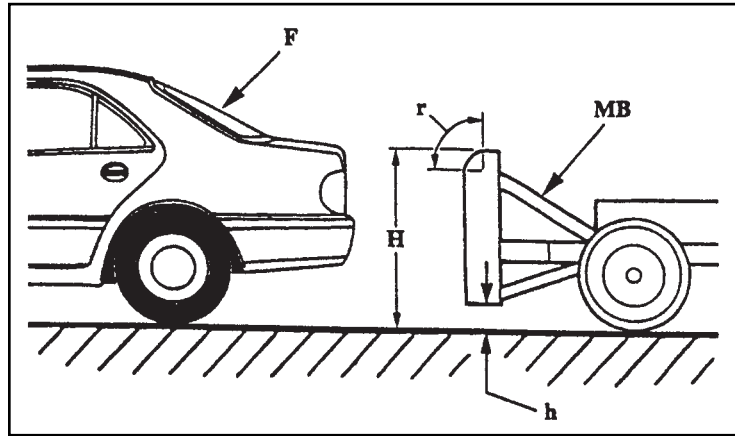
Left Hand Drive vehicle shown

KEY:

U	=	Offset 40%
B	=	Overall width of test vehicle
V_F	=	15.0 + 1.0 - 0 km/h
R	=	150 mm constant radius
F	=	Test vehicle

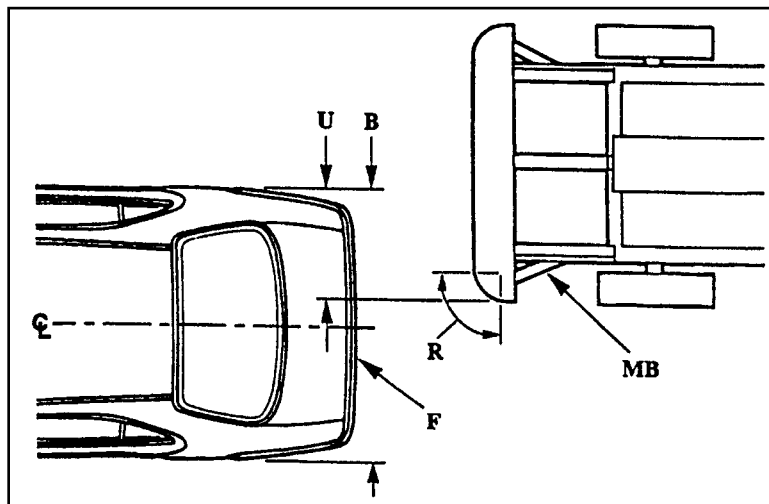
FIGURE 6.6
RCAR REAR CRASH PROCEDURE

Test Vehicle Mass: Net curb weight + 75 kg for driver and a full fuel tank or equivalent ballast.



KEY:

- MB = Mobile barrier
- M_{MB} = 1000 kg \pm 5 kg mass
- H = 700 mm barrier height \pm 10 mm
- h = 200 mm barrier ground clearance \pm 10 mm
- F = Test vehicle
- r = 50 mm constant radius



Left hand drive vehicle shown

KEY:

- MB = Mobile barrier
- U = Offset 40%
- B = Overall width of test vehicle
- V_{MB} = 15.0 + 1.0 - 0 km/h
- V_F = 0 km/h (handbrake off)
- R = 150 mm constant radius
- F = Test Vehicle