INSURANCE INSTITUTE FOR HIGHWAY SAFETY

August 14, 2009

Stephen R. Kratzke
Associate Administrator for Rulemaking
National Highway Traffic Safety Administration
1200 New Jersey Avenue, SE, West Building
Washington, DC 20590

Request for Comments; 49 CFR Part 581 Bumper Standard, Petition for Rulemaking; Docket No. NHTSA-2009-0047

Dear Mr. Kratzke:

On June 15, 2009, the National Highway Traffic Safety Administration (NHTSA) issued a request for comments (RFC) in response to a petition by the Insurance Institute for Highway Safety (IIHS) to apply the federal bumper standard to light trucks, vans, and SUVs, which NHTSA collectively refers to as light trucks and vans (LTVs). We are pleased to submit the following comments that address many of the specific questions raised by NTHSA in the RFC.

Current LTV Bumper Geometry

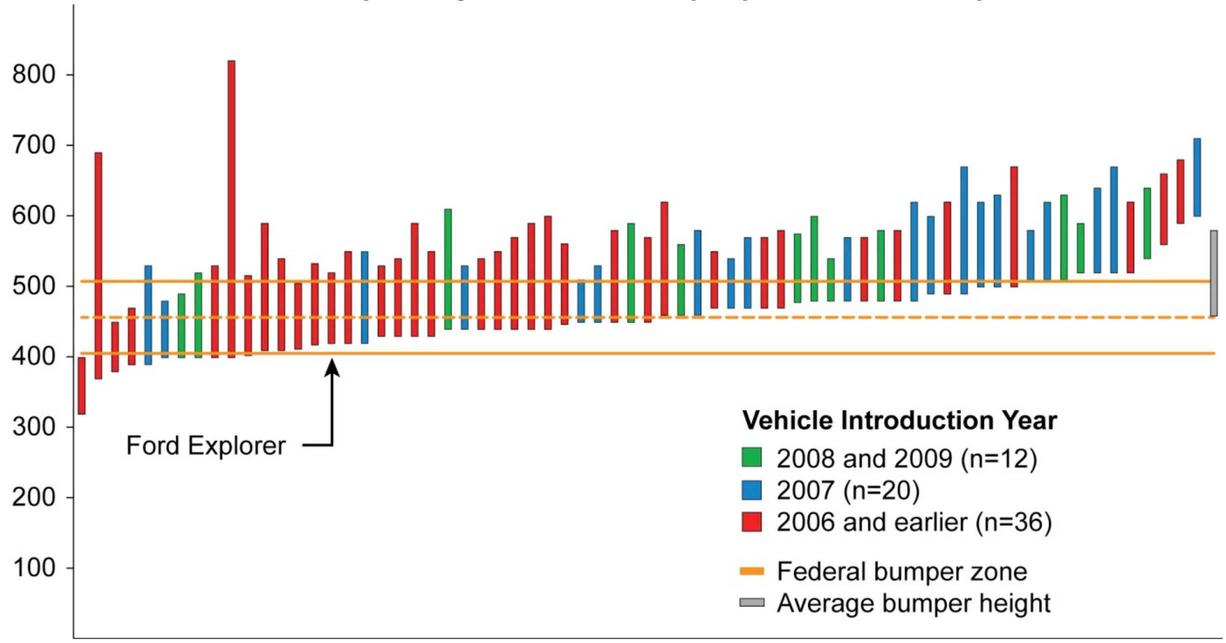
In our 2008 petition, IIHS cited two series of tests showing that the incompatibility between LTV and car bumpers can lead to excessive damage in low-speed collisions (IIHS, 2004, 2008). NHTSA requested information on how the geometry (i.e., bumper heights) of the SUVs used in the tests compared with that of current LTVs. Accordingly, IIHS measured the front bumper heights of nearly all light trucks in the US market — 68 total, including 66 current designs. The dataset includes front bumper heights of 12 small SUVs, 34 midsize SUVs, 7 large SUVs, 5 small pickups, 4 large pickups, and 6 minivans. Twelve of the vehicles are new designs introduced since 2008. In every LTV category, the average height to the bottom of the bumper is higher than the lower edge of the federal bumper test zone (406 mm) (Table 1).

Table 1
Average Front Bumper Height for LTVs

Vehicle class	Ground to bottom of bumper (mm)	Height of bumper (mm)
Small pickup	464	168
Large pickup	445	203
Small SUV	462	92
Midsize SUV	462	118
Large SUV	450	107
Minivan	435	108
All	457	119

Figure 1 shows the front bumper heights for all LTVs by year of introduction to the market. Only 2 of the 12 models introduced in 2008 or later fully span the federal bumper zone, 3 are completely outside the zone, and 5 cover less than half. These data suggest modern LTV designs still have bumper heights incompatible with passenger cars.

Figure 1
LTV Front Bumper Heights from Ground (mm) and Federal Bumper Zone



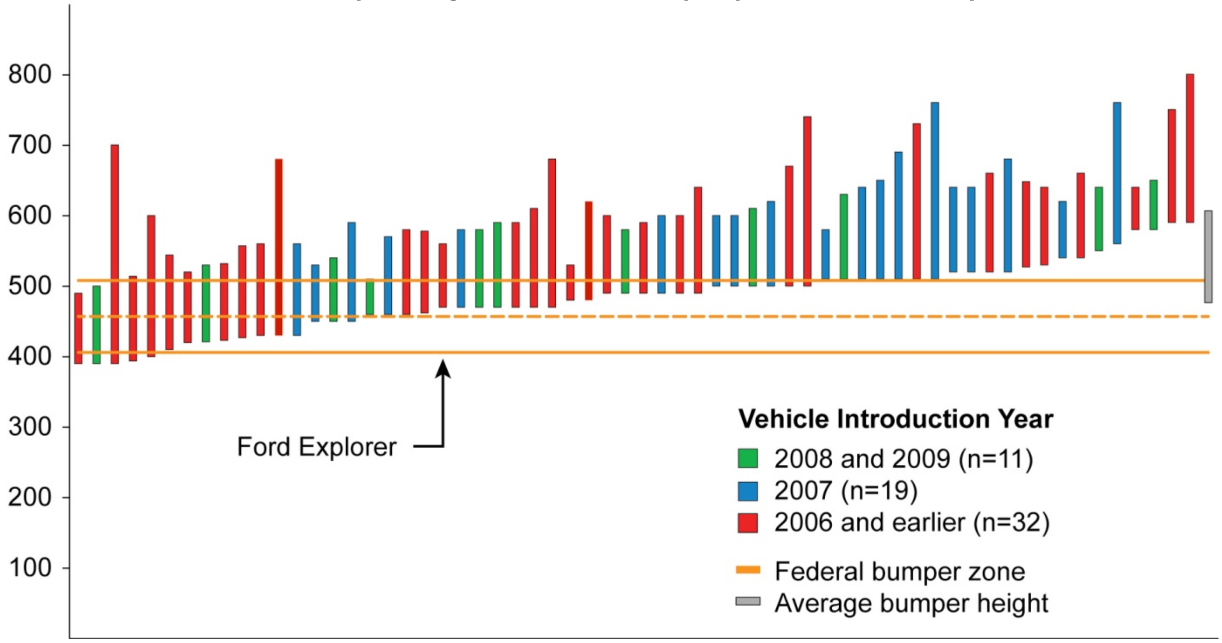
Rear bumper heights also were collected for 62 recent model LTVs. The dataset includes rear bumper heights of 10 small SUVs, 30 midsize SUVs, 8 large SUVs, 5 small pickups, 3 large pickups, and 6 minivans. Of the 62 bumpers that were measured, 60 are current designs. Eleven of these vehicles are new designs introduced since 2008. Like the front bumpers, the average rear bumper height in every LTV category is higher than the lower edge of the federal bumper test zone (406 mm) (Table 2). A complete list of the front and rear bumper heights is given in the Appendix.

Table 2
Average Rear Bumper Height for LTVs

Vehicle class	Ground to bottom of bumper (mm)	Height of bumper (mm)
Small pickup	454	222
Large pickup	513	190
Small SUV	486	93
Midsize SUV	489	122
Large SUV	511	140
Minivan	423	120
All	483	131

Figure 2 shows the rear bumper heights for all LTVs by year of introduction to the market. Seven of the 11 models introduced in 2008 or later have rear bumpers that span less than half of the federal bumper zone. As was found with the front bumpers, these data indicate rear bumper heights still are incompatible with passenger cars for many of the new LTV designs.

Figure 2
LTV Rear Bumper Heights from Ground (mm) and Federal Bumper Zone



Current LTV Compliance with Bumper Standard

The RFC asked for information on how many LTVs currently comply with the federal bumper standard. Without conducting the regulatory tests, it is not possible to determine exactly how many LTVs in the current fleet would meet the bumper standard requirements. However, by using the geometrical measurements, it can be determined how many LTVs have front and rear bumper bars in the federal regulatory zone. For front bumper bars, 18 percent are completely outside the federal bumper zone, and another 32 percent are higher than the middle of the zone. Rear bumper bars are even worse; almost 34 percent of rear bumper bars fall completely outside the bumper zone, and another 40 percent are higher than the middle of the zone. Many of the vehicles with bumpers outside the bumper zone would not comply with the federal standard.

Approach and Departure Angles

The RFC asked for information on how the functionality (e.g., off road, loading ramp) of the Ford Explorer, which has a bumper bar in the federal zone and performed well in the IIHS tests, compared with other LTVs. In the past, NHTSA has expressed concern that requiring LTVs to comply with the bumper standard would limit their functionality on loading ramps and in off-road situations. But this is not the case. In addition to measuring LTV bumper heights, IIHS measured approach and departure angles. The data show there is no correlation between approach angle and height of the lower edge of the front bumpers, and only a weak relationship between departure angle and rear bumper height. Approach angles ranged from 14 to 43 degrees, with an average of 27 degrees (Figure 3). Twenty-four of 63 LTVs had approach angles lower than that of the Ford Explorer (24 degrees). Departure angles ranged from 19 to 34 degrees, with an average of 25 degrees (Figure 4). Thirty of 55 LTVs had departure angles lower than that of the Ford Explorer (24 degrees). Most LTV approach and departure angles are limited by components below the bumper (e.g., soft plastic cover, fog lamps, air deflectors, valances, decorative trim, tow hooks, trailer hitches) and not by the bumper bar itself (Figures 5 and 6).

Figure 3
Front Bumper Height versus Approach Angle

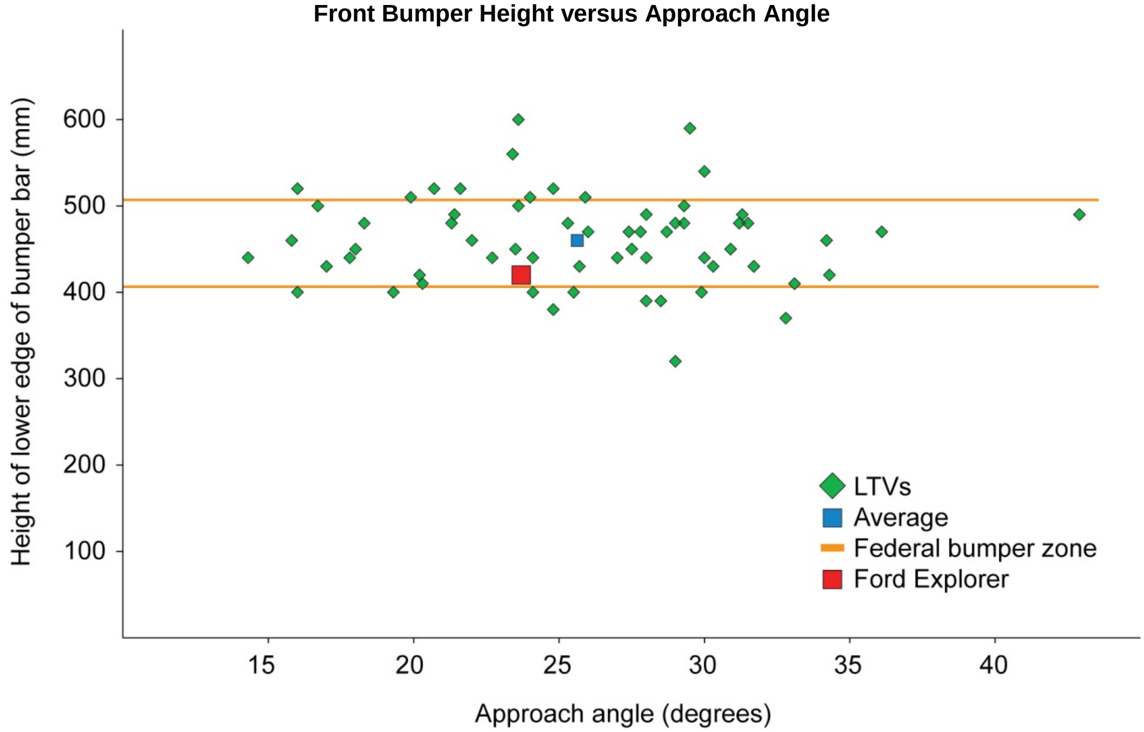


Figure 4
Rear Bumper Height versus Departure Angle

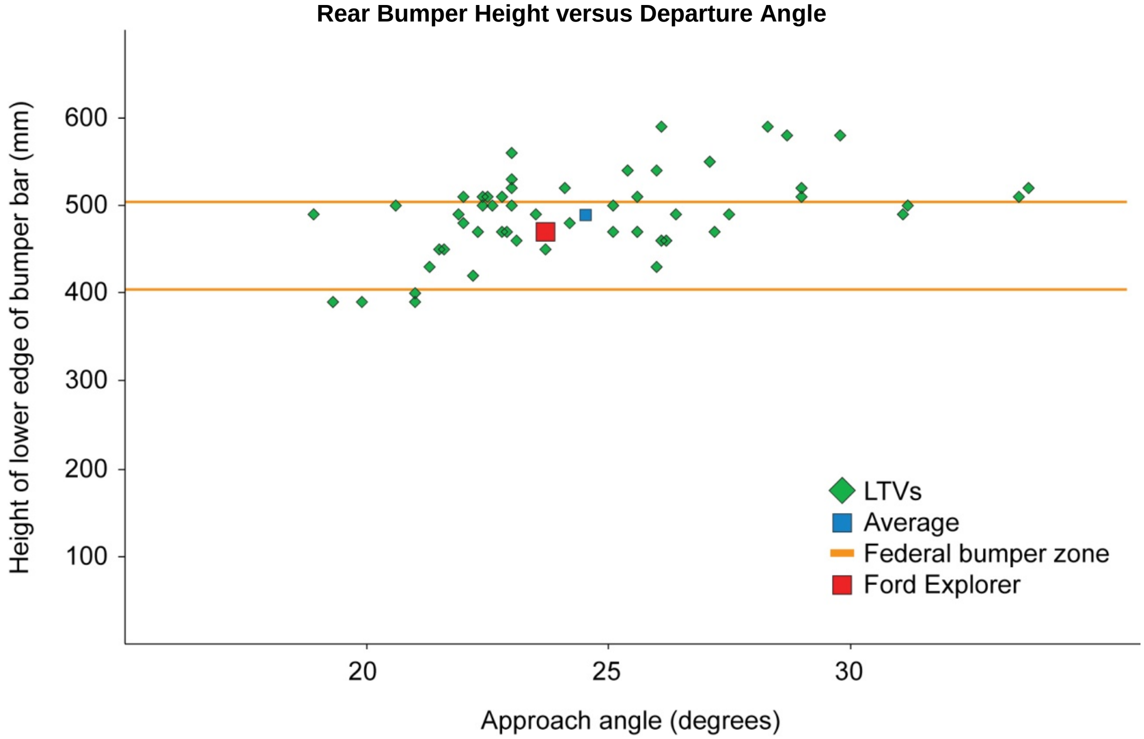


Figure 5
Structure below Bumper Limiting Approach Angle, 2008 Mitsubishi Endeavor

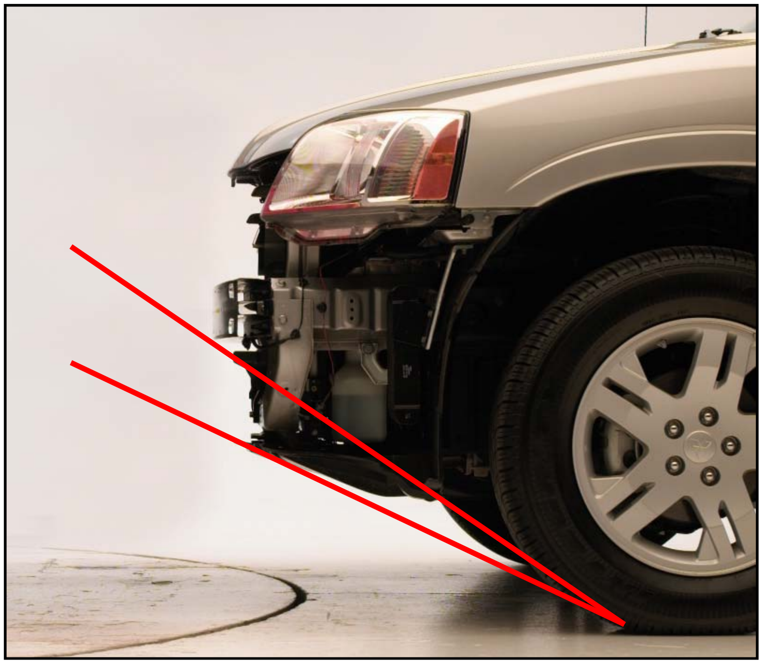
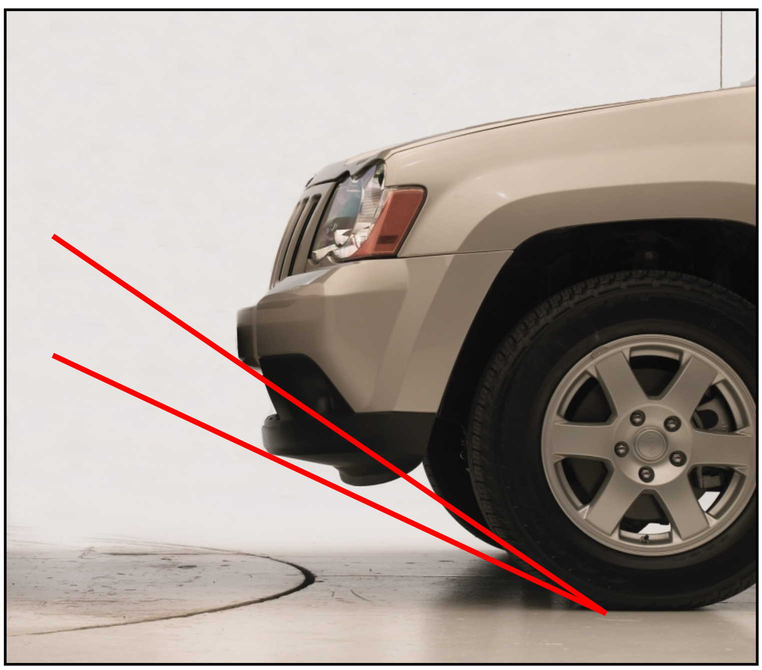


Figure 6
Structure below Bumper Limiting Approach Angle, 2008 Jeep Grand Cherokee



These data clearly indicate that other concerns (e.g., styling, wind resistance, engine cooling) dictate approach and departure angles for many LTVs. There exist technological means of increasing ride height when needed for off-road use. Some Land Rover, Audi, and Volkswagen models are equipped with electronic air suspension systems that switch on to raise the vehicle ride height. These technologies could be an effective solution for vehicles that are intended for off-road use and truly need the increased ride height.

Safety Implications of Extending Bumper Standard to LTVs

Compatibility

Requiring LTVs to comply with the federal bumper standard also will have added safety benefits. Analysis of data from the National Automotive Sampling System, Fatality Analysis Reporting System, and UK Co-operative Crash Injury Study indicate that LTVs are disproportionately involved as striking vehicles in side impact crashes where the occupants of struck vehicles sustained serious and fatal injuries (Augenstein et al., 2000; Lund et al., 2000; Thomas and Frampton, 1999; Zaouk et al., 2001). Pickups and SUVs typically have higher mass, ride height, hood height, and front-end stiffness than passenger cars, and these factors result in serious crash incompatibilities. Several studies have concluded that front-end geometry is the most important of these factors, greatly contributing to increased real-world injury rates in struck vehicles and higher dummy measures in controlled crash tests.

> **Factors contributing to front-side compatibility: a comparison of crash test results (Nolan et al., 1999):**
>
> Side crash tests conducted on a large four-door sedan showed large increases in struck driver thoracic injury risk when the striking vehicle (1997 Ford F-150 4x2) ride height was raised 100 mm. The increased injury risk was associated with increased door intrusion in the torso region. The study concluded that a first step for achieving front-to-side compatibility would be to address the geometry of front structures to allow for better engagement with side structures of other vehicles.
>
> **The effect of mass, stiffness, and geometry on injury outcome in side impacts – a parametric study (Seyer et al., 2000):**
>
> Ten moving deformable barrier (MDB)-into-car side crash tests were conducted with varying conditions to better understand how each factor influences injury risk. MDB ride height was increased by 100 mm from one test to another, enough so that the barrier no longer engaged the door sill structure of the struck vehicle. The largest effects on injury outcome were striking barrier ride height and increased impact velocity. As with the Nolan et al. (1999) study, increased ride height resulted in higher intrusion into the occupant compartment and higher thoracic injury risk.

More recent real-world evidence shows that aligning vehicle structures reduces partner vehicle fatality rates. In 2003, automobile manufacturers formed the Enhanced Vehicle Compatibility Technical Working Group to develop strategies to improve LTV compatibility with passenger cars in front and side collisions. In 2005, the group voluntarily agreed to lower the primary front structures of light trucks (typically bumper and frame rails) to span at least half of the federal bumper test zone. Alternately, manufacturers could install secondary energy-absorbing structures (e.g., Ford's BlockerBeam®) below the primary structures to improve structural interaction. IIHS estimated the benefits of the structure-matching agreement by studying the real-world crash experience of 2000-03 LTVs in collisions with cars during calendar years 2001-04. Driver fatality rates were compared between cars struck by LTVs that already met the structure-matching criteria and those that did not. Results indicated a 19 percent reduction in fatality risk to belted car drivers in both front-to-front and front-to side crashes with LTVs that met the voluntary requirements. Applying the bumper standard to LTVs should only improve structural interaction in crashes and thus provide additional safety benefits.

Pedestrian Protection

The RFC asked for information on the implications of applying the bumper standard to LTVs on pedestrian impacts. Several studies have indicated that pedestrians are at greater risk of serious injury or death when struck by LTVs than passenger cars (Ballesteros et al., 2004; Lefler and Gabler, 2004; Roudsari et al., 2004). It has also been suggested that front-end design and geometry, not mass or speed, is the major cause of the higher mortality rate for pedestrians struck by LTVs (Lefler and Gabler, 2004; Mizuno and Kajzer, 1999; Roudsari et al., 2004). Other research has indicated that pedestrians struck by LTVs are at a higher risk of above-knee injuries. This is consistent with the measured LTV geometry — almost one-quarter of LTVs have front bumper bars that are completely above the knee of the pedestrian legform used in European testing. LTVs with lower bumper beams should better distribute the load on the pedestrian legform, minimizing knee shear force and bending. The current bumper standard requires some amount of energy absorption in bumpers, typically foam, that should benefit pedestrians. Unregulated LTV bumpers often include rigid exposed face bars, protruding tow hooks, and other off-road appendages that may be more injurious to pedestrians compared with car bumpers.

Real-World Crash Statistics of LTVs

The RFC asked for information on the distribution of speeds at which LTVs crash. There is not a direct source for the number of crashes that are low speed. However, the distribution of insurance collision claims (i.e., cost to repair a vehicle for a driver deemed at fault in a crash) is a good indicator. About 55 percent of collision claims are less than $3,000 for frontal crashes and less than $1,500 for rear crashes. In the IIHS 10 mi/h front-rear crash tests between SUVs and passenger cars, the SUVs experienced an approximate 4 mi/h change in velocity. Front damage repair costs to the SUVs ranged from $868 to $2,848, and rear damage repair costs ranged from $824 to $1,279, suggesting the majority of real-world front and rear damage occurs at crash severities lower than 4 mi/h. A rigorous bumper standard would prevent or limit damage in these low-speed crashes.

Real-world data also show the high cost associated with bumper mismatch in low-speed collisions. IIHS surveyed damage to vehicles at five drive-in claims centers in the Washington, DC-metropolitan area between November 2001 and February 2002 (McCartt and Hellinga, 2003). Bumper underride occurred more frequently in car-to-LTV crashes, and damage repair costs were almost twice as high for vehicles that sustained underride compared with those that did not. Damage to safety-related components also was significantly greater in car-into-LTV crashes.

Reasons to Upgrade Current Bumper Standard for All Vehicles

IIHS has several published studies addressing the limitations of current bumpers (e.g., Aylor et al., 2005; Aylor et al., 2007). In summary, we have found there are three components of good bumper design that currently are lacking on many vehicles: geometric compatibility, stability during impacts, and effective energy absorption.

Geometric Compatibility

Aside from bumper incompatibility with unregulated LTVs, passenger cars subject to the federal bumper standard still have some geometric bumper incompatibility. The federal bumper standard specifies the minimum and maximum heights for test pendulum impacts (16-20 inches from the ground) but does not necessarily require that bumpers be mounted within the impact zone. For example, the Volkswagen New Beetle has a front bumper height of 14-17 inches, and the Hyundai Sonata has a front bumper height of 17-21 inches. Even at optimum static alignment, a 4-inch bumper zone is too small to ensure engagement with other vehicles in real-world crash scenarios such as hard braking, roadbed unevenness, and extremes in vehicle loading conditions. Another aspect of geometric incompatibility is the lack of adequate corner protection. Although the federal bumper standard includes corner impacts, the standard is so weak that manufacturers meet the requirement using the bumper cover alone, meaning most vehicle bumper beams end at the frame rails, leaving expensive headlamps and fenders at risk in low-speed corner impacts.

Stability

Even with ideal bumper alignment, some bumpers do not remain aligned during low-speed crashes. Rounded or ramp-shaped bumper covers and underlying foam impart vertical forces as the crash occurs, resulting in one bumper overriding the other. The federal bumper standard does not adequately assess stability during the impact and allows bumper deigns like the Pontiac G6, whose front bumper and underlying energy absorber are shaped like a ramp (Figure 7).

Figure 7
2007 Pontiac G6

Energy Absorption

The federal standard does not adequately address energy absorption. In 1982, the US bumper standard was weakened from a 5 mi/h test with a no-damage criteria to a 2.5 mi/h test that allows unlimited damage to the bumper system. Insurance claim rates for vehicles whose designs changed under the weaker standard increased up to 24 percent (IIHS, 1983a, 1983b). This is a logical outcome of reducing the required energy-absorption capability of bumpers by a factor of four.

For these reasons, IIHS (2009) in cooperation with members of the Research Council for Automobile Repairs developed a new bumper test procedure. The test more accurately reproduces the damage patterns that often are seen in real-world drive-in claims centers as a result of low-speed crashes.

Summary

Applying the federal bumper standard to LTVs will improve low- and high-speed crash compatibility with other passenger vehicles and will help reduce the frequency and cost associated with underride/override crashes. Lower compatible bumpers on LTVs also should improve their interaction with pedestrians. The LTV geometrical data provided debunk the argument that LTVs cannot have compatible bumpers because of off-road requirements. Most approach angles are limited by components other than the front bumpers. NHTSA should apply the federal standard to LTVs without delay.

Sincerely,

Joseph M. Nolan, M.S.
Senior Vice President, VRC Operations

cc: Docket Clerk, Docket no. NHTSA-2009-0047

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APPENDIX

		Front Bumper (mm)			Rear Bumper (mm)			Angle (degrees)	
Make and Model	Model Year(s)	Height to Bottom	Height to Top	Bumper Height	Height to Bottom	Height to Top	Bumper Height	Approach	Departure
Small Pickups									
Chevrolet Colorado	2004-2009	460	620	160	400	600	200	22	21
Dodge Dakota	2005-2009	430	590	160	390	700	310	25.7	19.9
Ford Ranger	1998-2009	590	680	90	500	670	170	29.5	22.4
Nissan Frontier	2005-2009	370	690	320	470	680	210	32.8	22.9
Toyota Tacoma	2005-2009	470	580	110	510	730	220	36.1	22.8
Large Pickups									
Chevrolet Silverado	2007-2009	520	670	150	560	760	200	16	23
Honda Ridgeline	2006-2009	470	570	100	470	590	120	27.8	22.8
Nissan Titan	2004-2009	400	820	420	590	800	210	29.9	28.3
Toyota Tundra	2007-2009	390	530	140	510	760	250	28.5	22
Small SUVs									
Chevrolet Equinox	2005-2009	410	540	130	430	560	130	20.3	26
Ford Escape	2008-2009	520	590	70	580	650	70	21.6	29.8
Honda CR-V	2007-2009	470	540	70	510	580	70	28.7	22.4
Honda Element	2003-2009	380	450	70	390	490	100	24.8	21
Hyundai Tucson	2005-2009	390	470	80	—	—	—	28	—
Jeep Patriot	2007-2009	500	620	120	490	600	110	29.3	31.1
Mitsubishi Outlander	2007-2009	600	710	110	450	530	80	23.6	21.5
Nissan Rogue	2008-2009	510	630	120	510	630	120	24	22.5
Subaru Forester	2009	480	580	100	550	640	90	25.3	27.1
Suzuki Grand Vitara	2006-2009	320	400	80	490	600	110	29	27.5
Toyota RAV4	2006-2009	480	580	100	—	—	—	29.3	—
Volkswagen Tiguan	2009	480	540	60	460	510	50	21.3	26.1
Midsize SUVs									
Acura MDX	2007-2009	470	570	100	510	650	140	26	29
Acura RDX	2007-2009	480	570	90	470	580	110	29	22.3
BMW X3	2004-2009	470	550	80	480	530	50	27.4	24.2
BMW X5	2007-2009	510	580	70	—	—	—	25.9	—

continued

		Front Bumper (mm)			Rear Bumper (mm)			Angle (degrees)	
Make and Model	**Model Year(s)**	**Height to Bottom**	**Height to Top**	**Bumper Height**	**Height to Bottom**	**Height to Top**	**Bumper Height**	**Approach**	**Departure**
Cadillac SRX	2004-2009	520	620	100	480	620	140	24.8	22
Chevrolet Trailblazer	2002-2009	440	590	150	430	680	250	24.1	21.3
Dodge Journey	2009	460	560	100	470	590	120	15.8	25.6
Ford Edge	2007-2009	510	620	110	500	600	100	19.9	25.1
Ford Explorer	2006-2009	420	520	100	470	560	90	23.7	23.7
Ford Flex	2009	450	590	140	490	580	90	18	18.9
Ford Taurus X	2005-2009	440	600	160	490	640	150	14.3	21.9
Honda Pilot	2006-2008	480	570	90	530	640	110	31.5	23
Hummer H3	2006-2009	410	590	180	520	660	140	33.1	33.7
Hyundai Santa Fe	2007-2009	440	530	90	520	640	120	28	23
Hyundai Veracruz	2007-2009	450	530	80	500	620	120	27.5	22.6
Infiniti EX	2008-2009	400	520	120	390	500	110	16	19.3
Infiniti FX	2009	440	610	170	—	—	—	30	—
Jeep Grand Cherokee	2005-2009	500	670	170	580	640	60	23.6	28.7
Jeep Liberty	2008-2009	—	—	—	—	—	—	31.3	—
Jeep Wrangler	2007-2009	490	670	180	510	690	180	42.9	33.5
Kia Sorento	2003-2009	430	530	100	490	590	100	31.7	26.4
Lexus RX330	2004-2009	450	580	130	460	580	120	30.9	23.1
Mazda CX-7	2007-2009	490	600	110	460	570	110	21.4	26.2
Mazda CX-9	2007-2009	480	620	140	500	600	100	18.3	23
Mercedes-Benz ML350	2006-2009	440	550	110	—	—	—	27	—
Mitsubishi Endeavor	2004-2009	560	660	100	540	660	120	23.4	25.4
Nissan Murano	2009	540	640	100	470	580	110	30	27.2
Nissan Xterra	2005-2009	420	550	130	500	740	240	34.3	31.2
Saturn Vue	2008-2009	400	490	90	450	540	90	19.3	23.7
Subaru B9 Tribeca	2006-2009	430	540	110	—	—	—	17	—
Suzuki XL7	2007-2009	420	550	130	430	560	130	20.2	21.3
Toyota 4Runner	2003-2009	430	550	120	490	600	110	30.3	23.5
Toyota FJ Cruiser	2007-2009	460	580	120	520	640	120	34.2	29
Toyota Highlander	2008-2009	480	600	120	500	610	110	31.2	20.6
Volvo XC90	2003-2009	490	620	130	527	648	121	28	—

continued

Make and Model	Model Year(s)	Front Bumper (mm) Height to Bottom	Front Bumper (mm) Height to Top	Front Bumper (mm) Bumper Height	Rear Bumper (mm) Height to Bottom	Rear Bumper (mm) Height to Top	Rear Bumper (mm) Bumper Height	Angle (degrees) Approach	Angle (degrees) Departure
Large SUVs									
Audi Q7	2007-2009	400	480	80	540	620	80	24.1	26
Chevrolet Tahoe	2007-2009	520	640	120	520	680	160	20.7	24.1
Dodge Durango	2005-2009	440	570	130	470	610	140	22.7	25.1
Ford Expedition	2007-2009	450	510	60	450	590	140	23.5	21.6
GMC Acadia	2007-2009	500	630	130	510	640	130	16.7	25.6
Mercedes-Benz R350	2006-2009	440	540	100	420	520	100	17.8	22.2
Nissan Armada	2004-2009	400	530	130	590	750	160	25.5	26.1
Minivans									
Chevrolet Uplander	2005-2008	450	570	120	462	578	116	—	—
Dodge Caravan	2008-2009	478	575	97	421	530	109	—	—
Honda Odyssey	2005-2009	412	505	93	427	557	130	—	—
Kia Sedona	2006-2009	447	561	114	423	532	109	—	—
Nissan Quest	2004-2009	403	516	113	410	544	134	—	—
Toyota Sienna	2004-2009	418	533	115	394	514	120	—	—