What is Front Override?

CAN IT BE PREVENTED?

Truck Impact Guards Are Needed At

the REAR

the FRONT

the SIDE

The front of a truck can go *over a car.*

June 26, 2009

Multiple cars rear-ended

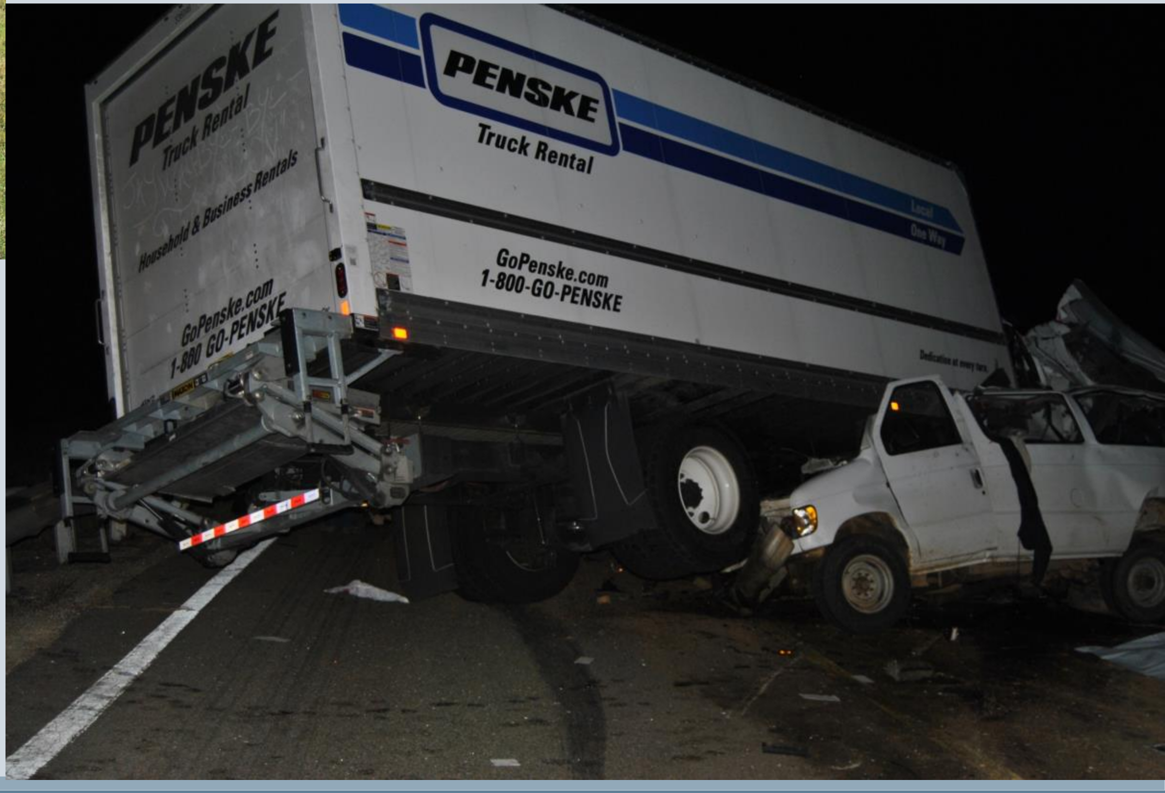
10 people died

June 3, 2019

Head-on

8 people died

Van driver survived



NTSB probes Okla. highway crash that killed 10

Heavy Vehicle Aggressivity

When crashes such as the Miami accident occur, the larger size and greater weight of the heavy commercial vehicle, disproportionate to the smaller, lighter-weight passenger vehicle(s), cause serious injury and often death to the passenger vehicle occupants, due to the larger vehicle's intrusion into the passenger vehicle's occupant compartment, resulting in loss of survivable space. In this accident, the front bumper of the Volvo truck-tractor was higher than the passenger vehicle bumpers and, as a result, the Volvo's bumper and stiffer frame entered the occupant compartments of the passenger vehicles. In the case of the Hyundai and the Kia, the Volvo also drove over the shorter vehicles. Further, the proportional difference in mass between the heavy commercial vehicle (40,400 pounds, unloaded) and the lighter passenger vehicles (the Kia weighed 2,600 pounds) was as high as 15 to 1; this, combined with the speed of the Volvo truck-tractor semitrailer traveling close to 69 mph at impact, compounded the disadvantage for the passenger cars and their occupants. The Volvo's speed contributed to the truck's tremendous kinetic energy at impact, which was dissipated during the collision with the slower moving and stopped passenger vehicles. Because of differences in vehicle weight and structural stiffness, as well as the geometric mismatch of bumper heights, the Volvo truck-tractor's design did not absorb the crash forces from the impact, and the dissipated kinetic energy was transferred to the lighter weight, less stiffer framed passenger vehicles. As a result, these vehicles were catastrophically destroyed.

Due to these factors, survivable space within the first four passenger vehicles struck by the Volvo truck-tractor semitrailer was minimal. Influencing the survivability of a crash for vehicle occupants are several factors: the degree of loss of occupant space, the crash force exerted on each vehicle occupant, and the postcrash environment. Variation in these parameters

NTSB Crash Investigation 2009 Front Override

can result in different outcomes for each vehicle occupant; while one passenger may be killed, another may sustain serious injury, and yet another may walk away uninjured.[2]

Consequently, although the Kia sedan's driver and two rear seat occupants (children in booster seats with 3-point restraints) and the Land Rover's rear seat child passenger survived due to the survivable space available to them, the Land Rover's driver and front passenger, all four occupants of the Hyundai, and all four occupants of the Ford Windstar were killed. The NTSB concludes that the combination of the high impact speed of the Volvo truck-tractor semitrailer and the structural incompatibility between the Volvo and the passenger vehicles resulted in extensive intrusion deformation and crush damage to the passenger compartments of the Land Rover, Hyundai, Kia, and Ford Windstar; a loss of survivable space in those vehicles; and the deaths of 10 passenger vehicle occupants.

Occupant protection demands that survivable space be maintained for all passengers and that the interior structure provide sufficient support and energy absorption so that crash forces are survivable. Differences in vehicle weight, stiffness, and structural components (resulting in geometric mismatch) are referred to as "vehicle aggressivity." Vehicles with high aggressivity, such as heavy trucks, often compromise the survivable space within any smaller vehicles they strike, in part because the difference in height between the two vehicles results in override and permits the stiffer elements of the commercial vehicle's front structure to intrude into the passenger vehicle. It is not practical to significantly reduce the weight of a truck-tractor semitrailer or to increase the weight of a passenger vehicle to better match the truck's; consequently, compatibility must be addressed through other means. Deflection of the passenger car and energy absorption into the truck frame might be achieved by design modification, thereby providing some reduction of heavy vehicle aggressivity.[3]

Research conducted in the United States and Europe has focused on ways to improve the

Head-on Truck Crashes Happen Frequently

The week of April 7, 2024, there were at least 3 fatal head-on truck crashes:

- Fatal head-on collision on I-40 in Del City early Sunday morning
- Fatal wrong-way crash in Putnam County claims Connecticut woman's life
- Man arrested in car, tractor-trailer crash that killed Vt. woman

LINK

Press Release on Australian FUP Law, 9/16/09:

- *FUP involves an impact barrier of prescribed strength and dimensions that catches or deflects a light vehicle during a collision to stop it sliding under a heavy truck. It can either be built in to the structure of the truck, or added on.*
- *By catching or deflecting the light vehicle, its occupant protection systems are then able to work effectively, mitigating injury to the light vehicle occupants.*
- *The international regulation (United Nations Economic Commission for Europe – UNECE – R 93) that the ADR is based on has been adopted in Europe. It will be adopted by Japan in 2012. It has not been adopted by the U.S.*
- *It is estimated that FUP will provide benefits of over $20 million a year (including lives saved and injuries reduced and averted), once fully implemented.*

http://anthonyalbanese.com.au/new-truck-safety-rule-to-save-lives-2

"The ***National Sheriffs' Association Traffic Safety Committee*** believes that this bill is vital to the efforts to prevent these crashes from occurring, first and foremost and also to lower roadway deaths, injuries, and property damage. . .

"This request is deeply personal to all of us and will protect our constituents on our roadways, protect our law enforcement officers and first responders, and lower deaths and injuries. "
Sheriff Harold Eavenson, Pres., NSA
Sheriff John Whetsel, Chair, Traffic Safety Committee

Lois Durso lost her precious daughter, Roya to a side underride crash on November 24, 2004. Marianne Karth lost AnnaLeah and Mary Karth due to a rear underride crash on May 4, 2013.

Their lives were snuffed out abruptly and needlessly – disturbing examples of preventable tragedies which are repeated in the United States hundreds of times a year.

We were sick & tired of waiting for someone else to do something, so we drafted the ***STOP Underrides! Bill***, which was introduced by Senators Gillibrand & Rubio, Congressmen Cohen & DeSaulnier on December 12, 2017.

2009 Crash Investigated by the National Transportation Safety Board:

10 fatalities

2017 California Crash:

2 killed, 6 injured in two cars

The Best Possible Protection

The Best Possible Protection

Front

Underride

Protection

an essential component of the STOP Underrides! Act

S.2219 & HR.4622

http://annaleahmary.com/
https://stopunderrides.org/

Underride Deaths 1994 – 2014
By Initial Impact on the Large Truck

Front: 625
Side: 1,534
Rear: 1,715
Other/Unknown: 132
TOTAL: 4,006 NHTSA, 2016

The STOP Underrides! Act of 2017

<u>This bill outlines standards and specifications for underride protection, including:</u>

- Underride protection at the **rear** of large trucks.
- Underride protection on the **front** of trucks..
- Underride protection on the **sides** of trucks.
- Underride protection on **single unit trucks**.
- **Research** for best possible protection.
- Guidelines and enforcement for guard **maintenance** and repairs.
- **Committee On Underride Protection**.
- **Retrofit** of existing trucks.

Fred Andersky, director, customer solutions, controls with Bendix, said at the North American Commercial Vehicle show that every 15 minutes in the U.S., a large truck rear-ends a passenger car.
https://www.trucknews.com/equipment/bendix-developing-next-gen-safety-systems/1003081127/

That means there is a potential front override 96 times/day, 672 times/week, 2,912 times/month, and 34,944 times/year! So, tell me why we would not want to have Front Underride Protection (FUP) on trucks in this country!!!

AGREEMENT

CONCERNING THE ADOPTION OF UNIFORM CONDITIONS OF APPROVAL AND RECIPROCAL RECOGNITION OF APPROVAL FOR MOTOR VEHICLE EQUIPMENT AND PARTS

done at Geneva on 20 March 1958

———

<u>Addendum 92:</u> Regulation No. 93

Date of entry into force: 27 February 1994

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF:

I. FRONT UNDERRUN PROTECTIVE DEVICES (FUPDs)
II. VEHICLES WITH REGARD TO THE INSTALLATION OF AN FUPD OF AN APPROVED TYPE
III. VEHICLES WITH REGARD TO THEIR FRONT UNDERRUN PROTECTION (FUP)

The United Nations Economic Commission of Europe issued a vehicle regulation on March 15, 1994, to prevent passenger vehicles from running under large trucks upon collision.

This standard was later adopted by Australia on September 16, 2009. Some Australian semi-trucks are designed like the European model. Others are modeled after the American model.

Truck manufacturers have installed Front Underrun Protective Devices (FUPD) on both types of tractors in Australia, including these companies:

- Mercedes Benz
- Kenworth
- Mack
- Isuzu
- Toyota
- Hino
- Isuzu
- Freightliner
- Western Star

*The **front underrun protection** prevents smaller vehicles in frontal crashes from being dragged under the body of a large truck. In its function as a high-strength steel abutment, it activates the energy-absorbing areas of the body of the advancing vehicle (crumple zones) so that the energy of the collision can be dissipated.*

Kirchhoff Automotive (Germany): https://www.kirchhoff-automotive.com/products/commercial-vehicles/front-underrun-protection/

. . . European Union countries have required front underride protection systems on all newly manufactured heavy-goods vehicles, which indicates that such a standard is feasible.

The NTSB concludes that collisions between passenger vehicles and the front of single-unit trucks or tractor-trailers are common types of crashes that result in fatalities, and front underride contributes to crash severity.

The NTSB therefore reiterates its prior recommendations that:

*(1) **NHTSA develop performance standards for front underride protection systems for trucks** with gross vehicle weight ratings over 10,000 pounds (Safety Recommendation H-10-12), and*

(2) that once the performance standards in Safety Recommendation H-10-12 have been developed, require all newly manufactured trucks with gross vehicle weight ratings over 10,000 pounds to be equipped with front underride protection systems meeting the performance standards (Safety Recommendation H-10-13).
*(*https://www.ntsb.gov/safety/safety-recs/_layouts/ntsb.recsearch/ecommendation.aspx?Rec=H-10-013*)*

Current Regulation

Iain Knight, Director & Principal Engineer,
Apollo Vehicle Safety (UK)

Original Equipment Manufacturer View

Reimert Sjoblom,
Expert Engineer Passive Safety,
Scania Group

Crash Data
& Future Needs

Rikard Fredriksson, Senior Advisor
at the Swedish Transport Administration

New Countermeasures & Test Methods

Rob Thomson, Professor of Vehicle Safety, Chalmers University of Technology (Sweden)

Front Override in the US

Keith Friedman, President,
Friedman Research Center

Recommendation #1

NHTSA should issue an Advanced Notice of Proposed Rulemaking on Front Impact Guards.

Recommendation #2

NHTSA should harmonize with global front override regulations, including UNECE-93 and any revisions to it, in order to provide improved motor vehicle safety, as indicated in Section 24211 of the IIJA:

> ***The Secretary shall cooperate, to the maximum extent practicable, with foreign governments, nongovernmental stakeholder groups, the motor vehicle industry, and consumer groups with respect to global harmonization of vehicle regulations as a means for improving motor vehicle safety.***
> (**IIJA**, p. 397, https://www.congress.gov/117/plaws/publ58/PLAW-117publ58.pdf)

SEC. 24211. GLOBAL HARMONIZATION.

49 USC 30101 note.

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(**IIJA**, p. 397,

https://www.congress.gov/117/plaws/publ58/PLAW-117publ58.pdf)

<u>General Recommendation</u>: The Secretary should recommend, and the President should establish, a *Presidential Advisory Committee on Integrity of Underride Research*. It should be composed of a diverse group of stakeholders, including:

(i) Truck and trailer manufacturers. (ii) Motor carriers, including independent owner operators. (iii) Law enforcement. (iv) Motor vehicle engineers. (v) Motor vehicle crash investigators. (vi) Truck safety organizations. (vii) The insurance industry. (viii) Emergency medical service providers. (ix) Families of passenger vehicle underride crash victims. (x) Families of Vulnerable Road User underride crash victims. (xi) Labor organizations.

The ACIUR should review all underride-related research, conducted by or contracted with the Department of Transportation, including the Statement of Work and the draft report prior to publication.

The following nine slides are excerpts from a University of Michigan Transportation Research Institute research study related to Front Override:

<u>Heavy Truck Aggressivity, UMTRI 2002 Study EXCERPT</u>

PROTECTING OTHERS

A study of fatal crashes between large trucks and cars by the Insurance Institute for Highway Safety estimated that front, rear, or side underride occurred in half of these crashes (*36*). A federal rule to upgrade the rear impact guard standard for new trailers took effect in January 1998. Underride in frontal collisions continues to be a major problem.

Overall, a collision of a light vehicle with a truck is more than twice as likely to produce a K or an A injury in the light vehicle than a collision with another light vehicle. The aggressivity of trucks is caused by their greater mass, the geometric mismatch between trucks and light-vehicle structures, and greater stiffness of trucks in comparison with light vehicles (*37*). Some general concepts as possible countermeasures have been proposed by UMTRI to improve the crash outcomes for light-vehicle occupants in collisions with heavy trucks (*38*). These are front underride prevention, a crash-attenuating truck front structure, a deflecting front structure, and a layered application of these countermeasures.

From the analysis of crash data, observation of crash damage, and collision and injury modeling analysis, when the impacting light vehicle underrides the front of the truck, the injuries to its occupants are likely to be severe, with a high probability of fatality. Further, the largest number of fatal crashes results from collisions with the front of the truck. The prevention of front underride may be accomplished either through changes in the truck frontal structure to ensure that these structural members are low enough to engage the crash-absorbing mechanism of the light vehicle or through the use of properly designed underride guards added to the existing truck structure. The analysis in the UMTRI study showed that a reduction of 27% to 37% in fatalities could be possible through prevention of front underride (*39*).

Once frontal underride is prevented, crash outcomes can be improved through proper management and dissipation of the collision energy. There are several examples of innovative truck structures that can perform such an energy dissipating function. These include front underride guards that are designed to deflect and absorb collision energy, truck fronts built of collapsible structural members, and an add-on (mounted on existing truck structure) crash attenuator. With more radical changes in truck design (changes in position of the truck engine, cab and associated structural members), it may be possible to achieve crush distances of as much as 12 ft, and it is estimated that a 25% to 50% reduction in fatalities can be achieved (*40*).

Another method of managing the collision energy is to deflect the impacting vehicle through the use of an appropriately designed truck structure. This produces large reductions in the collision energy absorbed by the light vehicle and greatly improves (46% to 72% fatality reduction) the resulting injury outcomes. The greatest drawback of this countermeasure is the possibility of secondary collisions, and further analysis of this aspect must be undertaken before adoption (*41*). Several distinct countermeasures could be used simultaneously in a layered system of aggressivity reduction to provide greater improvements in crash outcomes (*42*).

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Krishnaswami, V., D. Blower, L. Schneider, and D. Putcha. *Heavy Truck Aggressivity Reduction: Statistics, Analysis, and Countermeasures*. Final report for Contract DTNH22-00-C-07007. NHTSA, U.S. Department of Transportation, 2002.

EXECUTIVE SUMMARY

It is well understood, both through evaluations of roadway crash data and through crash analysis, that in collisions between trucks and light vehicles (typically passenger automobiles), the lighter vehicle suffers greater damage than in collisions with another like vehicle. This increased damage severity is termed agressivity and results primarily from the mismatch or incompatibility (in mass, structural strength and vehicle geometry) between the colliding vehicles.

This document presents a study that (i) Analyzed the causes of heavy truck aggressivity, (ii) Evaluated their relative importance (in terms of frequency of occurrence and injury outcomes of the occupants of the light vehicle) in the US traffic system, (iii) Derived detailed models relating collision factors (vehicle properties, speed, deceleration levels) to injury outcomes and (iv) Proposed and evaluated the benefits of truck structural countermeasures for mitigating collision severity (as suffered by the light vehicle).

4) Countermeasures: Based on the preceding analysis of crash data and the collision and injury models various aggressivity countermeasures were proposed and evaluated, with the focus being on the collision type responsible for the greatest proportion of damage and injuries (collisions with the front of the truck). Three principal countermeasures were analysed – prevention of front underride, crash attenuation using energy absorbing truck structures and reduction of the total energy dissipated in the crash process by deflection of the impacting light vehicle.

The first step in improving the crash outcome of the light vehicle and its occupant is to prevent underride through the use of suitably designed guards. Analysis of the crash data along with use of the collision and injury models shows that a reduction of 27%-37% in fatality counts are possible when underride is prevented depending upon the availability and use of occupant restraint systems (3-point seat belts, seat belt load limiters and pretensioners, and air bags) in the passenger automobile.

Once underride is prevented occupant injury outcomes can be improved through the apppropriate management of the collision energy, to reduce occupant Δv and deceleration levels. Two methods of such energy dissipation or management in truck/light vehicle collisions or strikes are (i) Attenuation of the collision forces or acceleration levels by increasing the time over which the collision Δv takes place, through the use of softer (less stiff) or energy absorbing

- Deflecting front structure: Another method of managing the collision energy is to deflect the impacting vehicle, through the use of an appropriately designed truck structure. This produces large reductions in the collision energy absorbed by the light vehicle and thus greatly improves (46%-72% fatality reduction) the resulting injury outcomes. The greatest drawback of this countermeasure is the possibility of secondary collisions, and further analysis of this aspect must be undertaken before adoption.

- Layered application of countermeasures: All the countermeasures suggested here were analysed independently, however they can be used simultaneously to in a layered system of aggressivity reduction (and of course in conjunction with other non-structural countermeasures) to provide greater improvements in crash outcomes.

In conclusion, this study provides a detailed analysis of the truck aggressivity problem in the context of the US road system, presents techniques and models for analysing collisions and injury outcomes, and shows that significant improvements in injury outcomes are possible throught the use of appropriately designed truck structural countermeasures.

Heavy Truck Aggressivity, UMTRI 2002 Study EXCERPT

FULL Study

Conclusions and Recommendations

The results from analyzing real-world crash/injury data and from performing computer simulations indicate that significant reductions in the likelihood of severe and fatal injuries to restrained front-seat occupants of light vehicles can be appreciated by implementing countermeasures on large trucks. These countermeasures will reduce the Δv and/or the deceleration of the light vehicle. Because of the relationship between Δv and deceleration level in real-world crashes and the absence of deceleration data in crash database, it is not possible to determine the benefits of countermeasures that reduce only the Δv of the light vehicle. However, it is likely that any countermeasure that reduces Δv will also produce the expected reduction in deceleration. While the results for the computer simulations conducted are

preliminary and for relatively optimal driver restraint conditions, they suggest that the benefits to countermeasures that reduce the deceleration of the light vehicle without reducing the Δv would be significant. However, further exploration of this issue through additional modeling with less-than-optimal restraint conditions and deceleration levels that are more appropriate to the Δv levels should be conducted.


Together, we are making
the roads safer!