

# Trailer Underride – Deadly From Any Angle

## By Joseph E. Badger

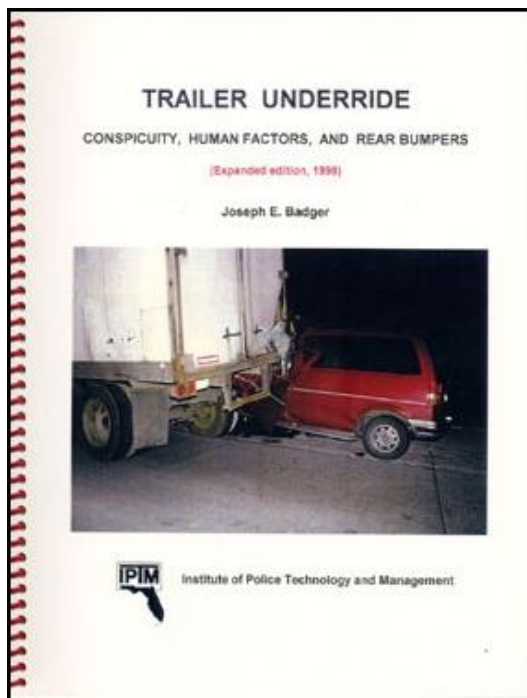
When heavy trucks, mainly tractor-semitrailers (at around 80,000 lbs. and more), and light vehicles such as cars and pickups (at less than 3,000 lbs.) collide, the losers are almost always the motorists. That is, as far as personal injury and property damage is concerned.

However, most of the time, when that personal injury (or death) occurs, it is likewise true that the trucker and the trucking company are also losers. Why? They have the deeper pockets.

Many traffic accidents (they call them *crashes* today) are precipitated by automobile drivers who do not comprehend – or are oblivious to – the vast handling differences between cars and semis. Heavy trucks cannot stop as fast, or in the same distance, as a car and cannot switch lanes or maneuver around hazards as do cars. So what is the trucker to do?

The type of car/truck collision with which I am most familiar is the dreaded “trailer underride.” These impacts almost always occur at night and are most often deadly. Too often – that probably should read most often – it was the trucker who caused the event.

Over the years working in law enforcement with the Indiana State Police, I had occasion to work a number of trailer underride cases. So many, in fact, that I wrote a treatise on the subject, titled *Trailer Underride: Conspicuity, Human Factors and Rear Bumpers*. Initially published in 1993 by the University of North Florida’s Institute for Police Technology and Management (IPTM), the dissertation was revised in 1995 and expanded to 73 pages in 1998. It is available from [www.iptm.org](http://www.iptm.org). Or click on <http://www.iptm.org/Webstore/p-56-trailer-underride-conspicuity-human-factors-and-rear-bumpers.aspx>



There are two types of trailer underride situations: Side underride and Rear underride.

## **SIDE UNDERRIDE**

Side underride typically takes place with only a few basic varieties and almost always at night or early morning. The first type happens when a trucker misses an intersection or place of business and decides to make a U-turn in some very dark rural area. A second type, and maybe the most common, is when a trucker attempts to back his rig into a loading facility. This can take anywhere from 12 to 20 seconds (or more) and during that time the tractor and semitrailer block both lanes of travel of the roadway from which the maneuver begins.

An unsuspecting motorist, who does not realize there is something the size of a house across the road, will often slam into the side and his or her car will squeeze below the semitrailer's bed. Depending on the speed of the vehicle and the amount of "stuff" (spare tire, fuel tanks, dolly, support beams) underneath. Occasionally, the car's top will sheer off and the car itself continues on for quite a distance. Most often, though, the vehicle simply wedges beneath the car, with the front seat occupants compacted inside.

These situations most frequently happen at night in places where motorists simply do not expect there to be any heavy trucks in the first place.

But they can happen in broad daylight or in a well-lighted area. For example, side underride can occur when a tractor-semi exits a truck stop and the trucker needs to cross a four-lane, divided highway. He may not appreciate the speed or number of vehicles on the far lanes and therefore has to stop his tractor in the median crossover. This causes the semitrailer to block the first set of lanes and thereby leaving motorists no escape route to get around the obstruction.

In the most common side underride case – the rig backing into a driveway or loading zone – as the car approaches the rig its driver sees the truck cab in the opposite lane. This is where such driver would expect oncoming traffic to be. However, the tractor's headlights often mislead the driver to believe both the tractor and semitrailer are in that other lane.

The closer the motorist gets to the opposite-direction tractor, the more the tractor's headlights affect his vision. By the time the motorist realizes there is something the size of a house sitting crossways in the road, there is not sufficient time or distance to avoid running into it.

There are times when motorists can see far beyond a semitrailer sitting across the road. They might even see traffic coming from the opposite direction. The headlights from the approaching vehicles can turn the semitrailer into a silhouette.

Another example, which sometimes takes place in the middle of the day, is on a four-lane divided highway when a tractor-semi is, say, traveling south and a car is heading north. The truck driver begins to negotiate a left turn from his lane to cross the median and the northbound lanes. An approaching motorist sees – and appreciates the size of the rig – but misjudges the truck's speed and assumes the semitrailer will clear the northbound lanes before he gets there.

There is one type of semitrailer that is worse than all the others when it comes to conspicuity. That is the flatbed that has either no cargo or a load covered with a black or dark tarpaulin. Motorists do not usually notice a section of black "something" four feet above and across the highway in front of them. Their headlights are aimed below the bed and there is nothing on top to reflect light.

Even with the retroreflective tape, the flatbed semitrailer is difficult to discern at night. Usually the rig is either stationary or moving very slowly and it does not let the motorist the nature of the obstruction.

## REAR UNDERRIDE

Picture this scenario: It is 3:30 a.m. on a stretch of interstate highway far away from city lights or the street lights on the entrances and exits of rest stops. A tractor pulling a semitrailer develops some sort of problem. Perhaps something is amiss in the engine; maybe an electrical issue; or something about the cargo or load creates a dilemma. So instead of driving at, say 65 or 70 mph, the trucker slows to 25 or 30 mph.

Meanwhile, the unaware motorist, who is probably tooling along at 75 or so, has been going around semis for a number of miles without difficulty. The driver sees the rigs ahead of him, judges an approximate closing speed, and simply changes lanes, goes around, and pulls back into his original lane.

This time, however, as the motorist approaches the slow-moving rig up ahead, he or she does not appreciate the difference in closing speed and catches the semi in half the time as all the others. The result too often is by the time the driver realizes that the rig is not moving at the usual highway speed, he has run out of sufficient time and distance to avoid running into the rear of the semitrailer.

Compounding the situation, the underride guard or Department of Transportation (DOT) bumper, as they are known, on many semitrailers are of inadequate strength to keep the striking vehicle from going beneath the semitrailer. This allows the lower rear of the semitrailer to smash into the car's occupant compartment.

The trucking industry generally proffers: "But the rig had all the required DOT lights and the motorist should have seen it."

Along the lower sides of semitrailers are as a rule three lights: an amber light on the lower front corner, another amber light in the middle of the bed and a red light at the rear corner. Often in side underride events, the angled tractor obstructs the front light and the rear light is off the edge of the pavement. The only light remaining for the motorist to see is the center one. Being amber or yellow, some times that light appears to be a light or reflector along the road, or even one of those reflectors delineating the centerline of a highway. Moreover, that single light is about four feet above the ground.

Many who have studied the "required DOT lights" agree that while sufficient as far as the regulations are concerned, they are still lacking in overall effectiveness. Many truck owner-operators equip their rigs with several additional lights to make them more visible... and recognizable for what it is. Just because there are a bunch on lights on something does not necessarily allow the viewer to know what the object is.

Every semitrailer must display along the bottom edge of the sides and read a red and white combination of DOT-approved retroreflective tape. Moreover, just because a semitrailer is equipped with the proper tape does not necessarily mean that a person who sees it will identify that it is on the side or rear of a semitrailer. If all the person sees is the tape – and cannot discern what it is on – he or she may think it is on a building or sign further down the road.

One needs to ... in this case ... erase the words *see* and *seen* from their vocabulary. Maybe not erase them entirely, but rather replace them with *perceive as a hazard*.

The rear underride guard or DOT bumper is sometimes referred to as the "Mansfield Bar." The reason for the name stems from an event that happened the early morning of June 29, 1967 involving a 1966 Buick in which actress Jayne Mansfield, her lawyer and their driver were front seat occupants.

Mansfield's three children were in the back seat. A tractor-semitrailer had reportedly reduced speed for a truck that was spraying for mosquitoes and the car driver, not aware the rig had slowed or did not perceive it as a hazard, crashed into the rear of the semitrailer. The three adults were killed; the children survived.

Thereafter, the National Highway Traffic Safety Administration mandated the installation of an underride guard. Unfortunately, many of the guards are not sufficiently substantial and simply "cave in" when struck by an automobile.

## **SIDE GUARDS**

In England and Japan, semitrailers have side rails that were originally designed to prevent motorcycles and bicycles from being under ridden in tight traffic. Soon it was discovered that while the guards did not prevent a crash from happening, they did keep vehicles from going under the trailer. (See photos of typical side rails in *Trailer Underride: Conspicuity, Human Factors and Rear Bumpers*, pp. 54-55, IPTM, Jacksonville, 1998.)

Keep in mind, if you are the truck driver or the motorist, a tractor-semitrailer – whether in front of you, behind you, or alongside – it is a potential hazard. And the higher the speed limit and the heavier the load, the greater the hazard.

If a semi jackknifes, the trucker becomes a passenger. It takes as little as 1.5 seconds for a tractor-semitrailer to reach a 15-degree angle jackknife for it to become unrecoverable. If only the rear axles of the rig lock up there might be some "trailer swing," but not a jackknife. If only the steering axle brakes lock, there will not be a jackknife; however if the drive axles lock up, jackknifing is almost inevitable.

What can and does happen when a tractor-semitrailer jackknifes on a 4-lane divided interstate highway is that it often ends up blocking all the lanes – and berms – in its direction of travel. When this sort of event occurs during darkness, motorists... even other truckers... will crash into the stationary and disabled rig.

## **DUMP TRUCKS**

While most underride cases deal with tractor-semitrailers, there are instances where the large unit is merely a dump truck and there is no trailer. (Ibid., p. 44.) Dump trucks, such as those often seen in Eastern Kentucky have beds over 25 feet long and do not have underride guards. Because the trucks are known to carry over 90,000 pounds of coal, the trucks occasionally travel slower than the regular flow of traffic.

## **DETERMINING SPEED OF UNDERRIDING VEHICLE**

In practically every accident case, whether an underride crash or not, the first question someone usually asks is, "How fast was he going?" There are a number of ways of calculating speeds, everything from measuring skidmarks to using fancy mathematical equations. When cars smash into trees, it is possible to measure the car's crush damage and come up with the amount of energy it took to create that damage. Crush can then be converted into speed.

In a normal collision where two vehicles hit one another, and bounce off in different directions, there are ways to compute the speeds of each vehicle. Speeds may be worked out when a vehicle falls off a cliff, vaults over a ditch, rolls over, hits a brick wall or otherwise is involved in a crash; however, in trailer underride (side or rear) collisions, it is nearly impossible.

Certainly, there are those crush formulas, but extreme caution must be considered before utilizing such equations. Because there are so many different frontal profiles of cars, pickup trucks, SUVs & vans and such, and semitrailer beds of varying heights off the ground, many crash scenarios do not fit the model of the crush equations.

## **READ MORE ABOUT IT**

The U.S. Department of Transportation Federal Motor Carrier Safety Administration's website describes various Codes of Federal Regulations such as "49 CFR Part 393," taken from the Federal Register.

It explains Federal Motor Vehicle Safety Standards (FMVSS) Nos. 223 (Rear Impact Guards), and 224 (Rear Impact Protection) and others. The site tells where readers may get more information about underride bumpers, plus it gives a History of Current FHWA Requirements. NHTSA and FHWA Efforts To Develop Improved Underride Regulations are also explained in great detail. At the bottom of the site are toll-free numbers for contacting the FMCSA.

View this site at <http://www.fmcsa.dot.gov/rules-regulations/administration/rulemakings/051498p.txt>

Stephen Hadley, whose wife Tamara Mills-Hanley was killed in a rear underride crash in 1993, developed and maintains the Underride Network website where one can read about Underride Guards, Vehicle Crash Compatibility, Vehicle Conspicuity, U.S. Truckers Rights, Roadway Design and Lane Departure, Truck Parking Safety and Vehicle Blind Spots.

The Underride Network provides Internet links to retroreflective tape manufacturers, makers of anti-jackknife devices and underride guards, safety merchandise and others. View this site at <http://www.underridenetwork.org>.

In March 1, 2011, the Insurance Institute for Highway Safety (IIHS) offered a news release titled "Underride guards on big rigs often fail in crashes; Institute petitions government for new standard." Adrian Lund, IIHS president, concluded the news release stating, "Underride standards haven't kept pace with improvements in passenger vehicle crashworthiness. Absent regulation, there's little incentive for manufacturers to improve underride countermeasures, so we hope NHTSA will move quickly on our petition." Access the news release at <http://www.iihs.org/news/rss/pr030111.html>

Two excellent photos at that site demonstrate the difference in vehicle damage when a car strikes the rear of a semitrailer with and without a substantial rear guard.

Lund stated in a letter to David Strickland, administrator of the National Highway Traffic Safety Administration (NHTSA): "Cars' front-end structures are designed to manage a tremendous amount of crash energy in a way that minimizes injuries for their occupants. Hitting the back of a large truck is a game changer. You might be riding in a vehicle that earns top marks in frontal crash tests, but if the truck's underride guard fails – or isn't there at all – your chances of walking away from even a relatively low-speed crash aren't good."

There is a February 1, 2010 article titled "European semi-trailer manufacturers working to comply to new underride regulation" posted at Karmak Technologies' website (<http://trailer-bodybuilders.com/truck-trailer/european-manufactures-comply-regulation-0201/>). The article begins with "A NEW underride (under-run) regulation with strength requirements twice current standards takes effect March 11 in Europe (sic). European semi-trailer manufacturers have been working to

develop guards that will meet the mandates of the European Commission's amendment of Directive 70/221/EEC. The rule strengthens a directive that was introduced in 2006."

Much like NHTSA's underride standards, the European guards are tested outboard, near the support members, and in the middle. The under-run protection on the outside (11.8 inches from the outside edge) and in the middle must be able to withstand a test force of 50 kN. This corresponds to approximately 5.5 tons. In the area of the longitudinal supports, the guard must withstand a force equivalent to 11 tons.

According to the website Patents.com, there is a patent (viz. 6,116,667) that purports to be "A vehicle bumper and underride crash guard protection device to prevent other vehicles underriding the protected vehicle. The bumper or guard system uses pre-tensioned brake plates which absorb energy by moving at a predetermined force. The bumper structure has a pivoting arrangement such that upon contact of the main bumper guard by a vehicle, the pivoting member transmits the horizontal force of the moving vehicle to the pre-tensioned energy absorption devices usually located under the vehicle. The bumper system allows large, load-carrying vehicles to comply with certain vehicle regulatory requirements for a crash guard bumper with the capability of deforming, moving or absorbing crash forces at predetermined impact points in a predetermined and regulated fashion."

A number of other devices claim to be strong enough to withstand considerable forces from vehicles that collide into the rear of semitrailers. However, no federal agency has yet mandated that any of these "improvements" be installed on new or existing semitrailers. And *mandated* is the operative word.

Another device, patent 7,086,674, has this interestingly worded abstract: An underride protection bumper for a trailer is provided which functions as two separate bumpers during different stages of impact to provide optimal energy absorption, impact vehicle ride-down and underride protection characteristics. Another underride protection bumper provides a support member extending diagonally inboard to counteract inboard-directed forces on trailer attachment member, thereby absorbing impact energy and minimizing underride of an impacting vehicle."

The above underride crash guard patents naturally deal with rear underride crashes.

Other devices have been developed for the side underride scenario. One such example is patent no. 8162384 which is described as "A side underride cable system configured to be coupled to a trailer includes a front mounting bracket assembly configured to be coupled to the trailer, a rear mounting bracket assembly configured to be coupled to the trailer at a location spaced-apart from the front mounting racket assembly, and a plurality of cables configured to extend at least partially along a length of each side of the trailer between the front mounting bracket assembly and the rear mounting bracket assembly."

Transports' Friend website promotes Road Safety and Operator Compliance. It is specifically designed for the Road Haulage Industry (Drivers & Operators), although it is a pertinent information resource to all involved in Road Transport. The link <http://www.transportsfriend.org/road/guards.html> describes with both text and illustrations a set of side rails designed to prevent side underride.

Images of various styles and types of side rails may be viewed at <http://www.bing.com/images/search?q=side+guards+for+semitrailers&qvvt=side+guards+for+semitrailers&FORM=IGRE>.

National Research Council Canada (NRC), also known as *Conseil national de recherches Canada* (CNRC) has a paper (CSTT-HVC-TR-158) titled "Side Guards for Trucks and Trailers." (CSTT

being the Centre for Surface Transportation Technology.) The paper is copyright protected, therefore this chapter will not directly quote any material, suffice it to say anyone truly interested in the side rail subject should review the study. It contains several color photographs of various side rails and fairings.

Just as “gap fairings” installed on the front of semitrailers help with fuel savings, the paper describes fuel & cost savings and lower CO<sub>2</sub> emissions at highway speeds on tractor-semitrailers with certain side rail guards. This paper likewise describes the effect (if any) that side rails have regarding their added tare weight and whether they might restrict airflow for brake cooling.

Japan has various laws governing side rails as does England. In those countries there is a considerably high number of bicycle, moped, and motorcycle riders. These conveyances as well as pedestrians have benefited immensely since semitrailers have been outfitted with side rails.

The addition of side-mounted rails favorably affects the aerodynamics of the entire tractor-semitrailer. Access the Canadian paper at [http://www.safetrucks.ca/resources/National Research Council Truck Side Guard Study 2010-03-01.pdf](http://www.safetrucks.ca/resources/National_Research_Council_Truck_Side_Guard_Study_2010-03-01.pdf)

One should note that with the addition of better, more substantial rear underride guards or side rails, none of the devices PREVENT accidents from happening. What they do, however, is minimize the severity and thereby lessen the potential for injury to life and limb.

However, without laws or regulations requiring manufacturers to install any of these innovations, primarily because of the cost, the public will have to be more aware of the dangers of underride. There also needs to be more education about the dangers of side and rear underride and about the retroreflective tape and what it means.

## **Tips for Truckers:**

Do not make U-Turns at night on 4-lane divided highways or at intersections especially in rural areas.

Do not back your rig into a driveway or loading facility at night. Your trailer may have the required marker lights, but the motoring public just may not perceive that the lights are on something angled across the road and in their path. Keep in mind that your headlights – shining in the eyes of oncoming drivers – may cause the drivers to be unable to even see your trailer. And be aware of how long it takes to stop, back up and clear all lanes when backing off a roadway.

Be careful when overtaking any vehicle on a two-lane road as it may take longer than expected to complete the pass.

When pulling to the left in order to make a wide, sweeping right turn, know that motorists may not know what you are doing and may attempt to pass you on the right.

When exiting a driveway or truck stop and entering onto a divided highway, take extreme care in discerning how long it will take to negotiate the maneuver and do not stop midway through the crossover that would cause your trailer to block highway lanes.

Passing small cars on interstates means you must really pay attention to where they are before returning to the right lane.

Remember that cars, especially small ones, can disappear behind or to the side of your rig.

Unless your trailer is a “wheels-back” unit or is otherwise an exempt trailer, make sure the underride guard – the DOT bumper – is substantial enough to withstand a collision from the rear without collapsing.

### **Tips for motorists (cars, SUVs, pickups, vans, &c.):**

Do not drive too close to the back of a semi as the trucker may not see you. Likewise, do not drive for any length of time parallel to a big rig. If you are going to pass, then pass; otherwise, fall back and return to the driving lane (and do not attempt to pass on the right).

Know that red and white reflective patterns may be on a semitrailer situated across the road in front of you.

Be aware that tractor-semitrailer rigs cannot stop as fast as you can. (It could take twice as long for them to stop.)

Understand the extreme weight difference between your vehicle and a tractor-semitrailer. If two such vehicles collide, the motorist will almost always lose.

Know that truck-tractors have blind spots. If you can't see the trucker in the cab's outside mirrors – or at least the mirrors themselves – chances are the trucker cannot see you either.

When passing a semi, do not cut in too quickly and be sure to signal your lane change.

If you are operating a motorcycle, consider that you are invisible to everyone else on the road. Assume that everyone else the right-of-way. If you are in a highway collision with just about anything else, chances are you will die.

Be aware that while many truck drivers have good driving records, there are those long-haul truckers who are doing everything possible just to stay awake. Car weights range from 1609 lbs. for a Smart Car (e.g., the ForTwo) to 3509 lbs for a Cadillac CTS-V and some SUVs such as the Lincoln Navigator can weigh over 5000 lbs. The gross weight of pickup trucks range from 5000 to 7000 lbs. Assume an average of 4000 lbs for “light vehicles.” That means a tractor-semitrailer at 73,280 lbs is 18 times heavier. If you are driving one of the light vehicles and tangle with a semi, you will lose.

### **About the author:**

Joseph E. Badger is an internationally known accident reconstructionist who has had over 100 articles published in such periodicals as *Law and Order* magazine, *Accident Reconstruction Journal*, *Accident Investigation Quarterly*, and others. Having retired after 20 years with the Indiana State Police, Mr. Badger resides in Bloomington, Indiana.