Tractor Trailer Underride - another look - and another

by Joseph E. Badger

Author's note: What follows is the complete, unedited manuscript -- with some added information -- that originally appeared in the Accident Reconstruction Journal (Sep/Oct, 1993). Reprinted with permission of the author. Although "tractor-semitrailer" is the more correct term, when the author uses the generic "semi," he means the entire rig, tractor included. Presented here with permission of the author.

When I first broached the subject of "Trailer Underride, The Almost Always Fatal Collision" [LAW and ORDER, May 1988], the focus was on investigating the problem. My follow-up article, "Trailer Underride Revisited" [LAW and ORDER, August 1992], dealt with some solutions. Both studies had to do with tractor/trailers that (1) backed across a highway into a loading area; (2) pulled out of a driveway; (3) made a U-turn, (4) were being driven slower than normal; or (5) are stopped on or parked alongside an interstate highway. Motorists have difficulty perceiving and identifying the rigs (if they see them at all) in time to avoid crashing into them. Unsuspecting drivers and passengers suffer incapacitating or fatal injuries when their cars run under the side or strike the rear of a semitrailer.

Visibility aside, there are other things that the trucking industry and safety officials can do to prevent the needless carnage of Trailer Underride. Some of these accidents occur when sleepy motorists drift off the edge of the roadway and run into the back of a parked or disabled tractor/trailer. In these cases, it makes little difference whether the trucker positioned safety triangles behind the trailer, had the 4-way flashers going, or if reflective tape emblazoned the rear of the trailer. In the instance of side underride, a vehicle might still strike an adequately marked trailer if the rig moved suddenly in front of a car that was too close for the driver to take evasive action. Once a vehicle hits a trailer, it doesn't matter how many lights or markings it has; the car still goes underneath. Should it?

On rear end protection, Federal Motor Carrier Safety Regulation, Section 393.86, states:

"Every motor vehicle, except truck tractors, pole trailers, and vehicles engaged in driveaway-towaway operations, the date of manufacture of which is subsequent to December 31, 1952, which is so constructed that the body or the chassis assembly if without a body has a clearance at the rear end of more than 30 inches from the ground when empty, shall be provided with bumpers or devices serving similar purposes which shall be so constructed and located that: (a) The clearance between the effective bottom of the bumpers or devices and the ground shall not exceed 30 inches with the vehicle empty; (b) the maximum distance between the closest points between bumpers, or devices, if more than one is used, shall not exceed 24 inches; (c) the maximum transverse distance from the widest part of the motor vehicle at the rear to the bumper or device shall not exceed 18 inches; (d) the bumpers or devices shall be located not more than 24 inches forward of the extreme rear of the vehicle; and (e) the bumpers or devices shall be substantially constructed and firmly attached."

What that single-sentence mouthful says is that if the back of your trailer is more than 30 inches off the ground, put a bumper on it. Perhaps the rationale behind the 30 inches is that the hoods of most passenger cars (at windshield level) are between 35 and 40 inches above the ground; therefore, such cars couldn't fit under the back of a trailer. Not!

One of the weakest parts of a car is the hood. At highway speeds of 55 miles an hour, or even at 30 mph, when a car runs into a semitrailer the hood peels back and exposes the car's front seat occupants to a crisis. The regulation does not address the strength or impact-absorbency of the bumper except to say that it must be "substantially constructed," whatever that means. Moreover, the rule says nothing about protective guards along the sides of trailers.

According to the Insurance Institute for Highway Safety (IIHS) [Status Report, July 11, 1992] as many as 151 deaths in underride crashes may be occurring each year . . . [the] proposed 22-inch maximum ground clearance for rear underride guards is preferable to the 30 inches now allowed, but it's still way too high." And what about those "substantially constructed" bumpers? "Care should be taken so underride

guards aren't completely rigid [as] automobile occupants are best protected by energy-absorbing guards." There are rear bumpers available with energy-absorbing features like hydraulic shocks or rubber blocks. The Institute also says the National Highway Traffic Safety Administration (NHTSA) should be addressing side underrides, noting that deaths in such crashes "are at least as common as those associated with rear underride crashes."

"A coalition organized by the Citizens for Reliable and Safe Highways (CRASH) wants a much stronger truck underride standard than NHTSA is contemplating." [IIHS Status Report, Vol. 27, No. 7.] During a Washington, D.C. press conference, Joan Claybrook, Co-Chair of CRASH, noted that "Underride crashes occur when automobiles that run into the backs of huge trucks are squeezed underneath like so much toothpaste . . . With the car's force-absorbing bumpers and engine compartment sliding below the mass of the truck's body, the top of the passenger compartment hits the truck full force and is guillotined off like a knife through Crisco."

Members of the coalition include not only CRASH but representatives from Advocates of Highway and Auto Safety, the American Academy of Pediatrics, the American Insurance Association, the Center for Auto Safety, the Consumer Federation of America, the Institute for Injury Reduction, the National Association of Governors' Highway Safety Representatives, the National Head Injury Foundation, Public Citizen, and the Trauma Foundation. [Ibid.]

CRASH's working agenda calls for antilock brakes, on-board recorders, and splash/spray suppression devices, plus rear and side impact guards. Those guards should be designed to "reduce crash forces on occupants of passenger vehicles striking the rear ends and sides of single-unit and combination trucks." [CRASH Newsletter, Vol. 2, No. 2.] The coalition also wants only 16 inches of ground clearance on the rear bumper instead of 22. Many automobile bumpers, however, are less than 14 inches above the ground, so lowering an impact-absorbing rear trailer bumper to 14 inches might be better. The vertical center of the car's bumper (in line with the frame) should match the lower bumper plate on the rear of the trailer.

According to the coalition, too many trucks would be exempt from NHTSA's proposed standard. Therefore, the group wants the underride requirements to apply to straight trucks weighing more than 10,000 pounds as well as to tractor/trailers.

Some good news: On January 18, 1996 (for trailers manufactured after that time), the DOT lowered the rear bumper height from the ground from the earlier 30 inches to 22 inches. Advocates such as CRASH wanted them lower, but some improvement is better than no improvement.

Thus far, this article covered tractor/trailers, the drivers of which probably thought what they were doing was just fine. Truckers who figured it was okay to back across a poorly lit road or park on the emergency berm of an interstate highway. But how many truckers stop their big rigs along a highway because the driver is tired (as opposed to mechanical troubles with the truck)? A 1985 Commercial Vehicle Safety Alliance study found that 41 percent of all truck crashes had fatigue as a probable contributing circumstance. Many of those crashes end with a jackknifed tractor/trailer being crosswise in the road. The initial collision renders the electrical system inoperative and the single, double--and even triple trailers--completely block all lanes. A prime target for a subsequent underride accident.

While the rule-makers at NHTSA contemplate changes to the Federal Motor Carrier Safety Regulations, what can law enforcement do to stem the tide of underride collisions? A recent survey found that 19 percent of truck drivers questioned admitted to falling asleep at the wheel at least once in the month prior to the survey. Log books, commonly called "Lie Books," "Joke Books" or "Cheat Sheets" may show a driver has been behind the wheel a couple of hours when actually it's been several. When you ask to see a trucker's log book, ask for the other one, too. During an accident investigation, don't stop looking when you find a log book in the truck cab. Chances are, another is secreted between or under the seats or in the sleeper berth. Explore the truck cab for gas receipts. Many such receipts list the date AND TIME of a fuel purchase.

If, when on patrol, you see a semi parked along the highway, check it out. Is the rig disabled or is the driver taking a nap? Parking at the edge of the road because the driver is sleepy may seem like an emergency to the driver, but it's an underride accident waiting to happen. If nothing else, escort the outfit to the nearest exit or, on a non-interstate highway, to an area where the driver can park the rig and not present a hazard. Notify the trucking company and keep a record of the date, time, and the name of the person with whom you spoke. Many reputable trucking companies have specific guidelines about improper parking but safety directors or company officials won't learn of the incident unless an accident occurs or someone tells them about the situation. The driver certainly isn't going to admit any wrong doing so it's up to the police officer to let trucking company officials know what's going on.

In the event of an accident, investigators should advise drivers and officials what could have been done to prevent the accident or lessen the injuries. If the DOT bumper collapses in a rear-end collision, perhaps the bumper was not "substantially constructed." Investigators should inspect tail lamps and side-marker lamps to determine if they were off or on at impact. If you, as the at-scene investigator, do not know how to make such a lamp examination, preserve the bulb(s), using proper evidence-collection methods, for someone who does.

When a moving vehicle strikes a stopped semi in the rear, it shoves the semi forward. However, if the trucker set trailer brakes, the possibility is good that the tires left marks on the pavement. Document those marks with measurements and photographs. This documentation helps place the location of the rig in relation to the edge of the road.

In any underride accident, whether the semi was moving or stationary, photograph the sides and rear of the trailer. If the marker lamps are off, note it in your report before you take flash photos. Often it will appear in pictures that the lamps were lit due to a reflection of the camera's flash. Note whether the trailer has retroreflective tape or paint.

Keep in mind that most semitrailers--with a few exceptions--manufactured after December 1, 1993, must be outfitted with retroreflective tape, in mandated patterns and colors, on both the rear and sides. Organizations such as CRASH urges its members--and this could include accident investigators whether a member or not--to keep pressure on the Federal Highway Administration (FHWA). You're encouraged to express opposition to weakened hours-of-service restrictions for truck drivers and to let FHWA know about trailer underride accidents where better bumpers or the presence of side guards would have prevented death or at least lessened injuries.

Granted, many motorists who have underridden the rear or side of a semitrailer had a bit too much to drink. However, nighttime trailer underride crashes usually involve sober drivers. Older drivers have difficulty discerning distances between them and a truck ahead. By the time motorists perceive a stopped or slow-moving truck, they do not have enough time or distance to stop or swerve.

A friend who knew of my profound interest in the trailer underride phenomenon thought maybe I was overstating the problem. "I mean," he said, "just how hard can it be to see an object nearly as big as a house in front of you?" Then one night, on an ordinary two-lane road, he happened to glimpse a piece of a dark object barely miss his hood and pass by his driver's side rear view mirror. He looked back over his shoulder in time to see that the front of his car had passed under a corner of a semitrailer. My friend was lucky. He noted later that the trailer's clearance lights were on but apparently they were dirty enough that he simply saw nothing until the trailer was but two or three feet in front of him.

Police who patrol our streets and highways must realize how practically impossible it is to distinguish huge trailers at night, especially in pursuit cases. One of Indiana's Finest, responding to an officer-needs-help call, completely underrode a semitrailer that made an illegal turn across a 4-lane, undivided highway. His squad car went under one side of the trailer; half the car came out the other side. There was not one inch of pre-collision skidmarks.

Accident investigators will find, when in court on underride crash cases, "experts" for the other side may testify that a particular roadway was free from obstructions and that the victim should have seen the

offending vehicle--and could have avoided the collision. That's partially true. Motorists probably can see a certain distance away but that doesn't mean they will perceive or recognize a distant object as a hazard.

The FHWA commissioned Biotechnology to perform time/distance studies regarding the underride situation. Those studies' results show that a driver "with average reflexes, eyesight, decisiveness and sobriety, driving an average car" [at 60 miles an hour] will take almost THREE seconds to see and recognize a hazard [e.g., the back of a semitrailer], almost SEVEN seconds to decide on a course of action, and almost 4.5 seconds to complete a maneuver.

This is not to say that the "rule of thumb" to allow 100 feet of stopping distance for each 10 mph, is entirely invalid. But at night, when a tractor-semitrailer blocks the road, motorists must identify the problem when they are one-quarter mile away.

In the 14.5 seconds necessary to see, perceive (recognize), decide what to do, and then do it, a vehicle will travel 1,276 feet. If the recognition begins a quarter mile away (1,320 ft), the motorist has a "cushion" of 44 feet. That quarter mile is what's called the "Decision Sight Distance," and it's based on nighttime traffic traveling at 60 mph.

I worked a case that involved a tractor and a dirty white box-type trailer. The truck driver had missed his destination, stopped along the edge of a two-lane road, at night, and decided to turn around. He backed his rig across the highway into an intersecting county road. Although he saw two approaching cars, he assumed he could finish backing before they got close enough to be a problem. Wrong. When the semi was midway through the maneuver, the lead car slammed into the trailer in front of the rear duals. The weather was misty and the roadway was damp.

A woman in the second car saw the semitrailer when the headlights of the car in front of her illuminated the side of the trailer. However, she testified that she did not recognize it as a hazard for she thought it was merely a heavy patch of fog. An "expert," called by the trucking company, measured the available distance the victim had to see the semi and concluded that she should have seen it. Keep in mind it was dark and misty, there were no ambient lights, the tractor faced the car from the opposing lane and the tractor's headlights made it look as though the rig was in its proper lane. Moreover, the semi was in a rural area and in a position a reasonable and prudent motorist would not expect, crosswise and blocking both lanes and shoulders.

Another underride case involved a semi that pulled out of a truck stop onto a four-lane divided highway. When the tractor was in the median crossover, the trailer extended back across the two lanes between the truck stop and the median. A motorist came along and underrode the trailer. This time there was no fog and the incident occurred by a truck stop (where motorists could expect to find trucks entering and leaving). The tractor's headlights did not shine toward approaching traffic and the trailer bore all proper DOT lights and reflectors. However, the same "expert," hired by the motorist this time, concluded there was no way the woman in the car could have seen the trailer. Go figure.

Often a question arises about whether it would be beneficial to a case to perform a video "reenactment." Besides the obvious dangers, use care to operate quality equipment. Assuming the location is protected and all the vehicles are in place, don't merely prop a camcorder on someone's shoulder and start shooting. Nighttime videotaping often proves ineffective. It is quite difficult to replicate in a camera what the human eye perceives--or doesn't--at night. Take care to assure that lighting on the tape represents accurately the conditions at the scene.

Many times during a video session, people unscrupulously or unwittingly adjust the gain (light intensity or amplification) on the camcorder to see what's going on in the view finder. This affects the amount of light recorded on tape. Though it's a simple matter to play back the recording on the camcorder, the view screen is so tiny it's not going to give a full sense of how the same picture will look on a television screen. With the introduction of too much light, oncoming headlights may resemble locomotive beacons; if insufficient light gets recorded, people watching the tape may believe it was darker that it really was.

Another problem with camcorder taping is the lens. A regular lens captures a specific area in a particular depth of field. The only way to see more area is to pan the camera left or right or zoom out. If this camera movement is too fast, it is difficult to follow when watching the tape. The human eye makes a panoramic sweep in an instant; therefore, a person at the accident site may see more peripherally than that shown on the video.

Further, in a clinical situation (reenactment), when a person knows ahead of time what he or she will see when watching a video, an object may be perceived earlier because the person expects to see it. The same object may not have been recognized at the time of the accident because the driver did not anticipate the object.

Other problems, inherent in still photography, exist with video taping. Many police departments routinely make videos of accident scenes. Use them as a supplement to- not a replacement of- still pictures. Photograph vehicles without using a flash attachment (use a tripod for time exposures) and take additional photos with a flash. Don't just shoot closeups. Take pictures from drivers' perspectives. Take similar photos in daylight.

Trailer underride accident cases usually end in litigation. Don't harbor a feeling during an investigation that the cause of the collision is cut-and-dried and will never go to court. Murphy's Law says it will.

For more on the topic, read "Trailer Underride: Conspicuity, Human Factors and Rear Bumpers" by Joseph E. Badger, published by The Institute of Police Technology & Management (IPTM), University of North Florida, 4567 St. Johns Bluff Road, South; Jacksonville, FL 32224-2645.

Trailer Underride Revisited

by Joseph E. Badger

Author's note: What follows is the final draft of a manuscript accepted by Law & Order magazine and published in August 1992. Presented here with permission of the author. Minor changes have been made for this electronic entry.

Prior to my retirement from active law enforcement (November 1988), I reconstructed an inordinate number of side "trailer underride" accidents. This prompted my first article on the subject, "Trailer Underride: The Almost Always Fatal Collision," (Law & Order, May, 1988). For those of you who missed it, the side trailer underride phenomenon to which I refer is the type of night-time accident where a tractor-semitrailer stops on a roadway and the driver begins a backing maneuver into a driveway or loading dock area. It can also happen when the driver pulls the rig out onto the highway from a loading zone or driveway, but this occurs less often.

On-coming motorists, unaware that the trailer is across the road, see the headlights of the tractor and merely assume the lights are on a truck in its proper lane. Of the three typical trailer side marker lamps, one is blocked from view by the tractor and the other is off the roadway into the driveway. That leaves only the center marker lamp visible to the motorist. As the amber light is quite small, it may be mistaken for a roadside reflector, the type used on mailboxes, utility poles and as driveway delineators. Although it can be seen, the motorist does not perceive it as a hazard until it is too later.

Since I wrote the 1988 article, I have become involved with the reconstruction of numerous other types of underride cases where conspicuity is a problem. Certainly, we have all been called to accidents where someone runs into the rear of a semitrailer on the open highway. Everyone testifies that the taillights on the trailer were on which begs the question: "Why did the motorist run into the back of the trailer?" Part of the problem is driver expectation. What can a reasonable and prudent person expect when driving at night? If on an interstate, most of the large trucks run "in the vicinity" of the speed limit. Car drivers expect that. If, however, a semi has pulled directly onto the roadway from the emergency lane or for some reason is traveling, only 30 MPH, a motorist may see the taillights and clearance lights but gains on the truck faster than expected. By the time the driver realizes the truck is going much slower than normal, he or she may be too close to avoid it.

In its publication "Conspicuous Problems...Conspicuous Solutions," 3M defines conspicuity as "The degree of observability of an object. The ease by which an object can be perceived. Drivers recognize objects by five visual cues of conspicuity: Detection, Estimate of Distance, Determination of Length, Assessment of Shape, and Definition of Object's Relative Position."

There are also instances of vehicles running into the rear of tractor/trailers that are parked on the emergency strip. Since the emergency strip is clearly that, a stopping place for emergencies, a driver unfamiliar with the road may perceive the truck ahead to be merely going down the road in the driving lane. In too many cases, truckers fail to place warning devices (reflectorized triangles) behind the trailer so there is nothing to alert the motorist that something is amiss. A motorist may see the taillights and/or clearance lights on a trailer but--again quoting the 3M publication: "'Red dot confusion', or the difficulty in interpreting lights a driver sees at night, adds to the problem. Too often, car drivers don't see trucks until too late."

There are also cases, usually in industrial areas, where a car on a side road comes to a cross roadway. A slow-moving tractor passes by the side road and the motorist pulls out only to run into and under the unseen semitrailer.

This article deals with yet another situation that results in the hazards of trailer underride. Besides pulling out of - or backing into - driveways, other dangerous maneuvers often end in tragedy. One such is a tractor/trailer making a U-Turn at a crossover on a 4-lane, divided highway (or any U-Turn in a rural, unlit area).

These nighttime accidents generally take place in an area where ambient light is almost non-existent. The tractor/trailer is going one direction and at some point in time the driver realizes it is the wrong direction. Rather than continue ahead to find a more suitable place to turn around, the driver attempts to make a U-Turn at a crossover, intersection, or in the middle of nowhere.

In one example the driver begins the U-Turn but due to the length of the rig cannot complete the maneuver in one fell swoop. He gets half-way though the turn, stops, and jockeys back and forth until he can continue forward. Because the trailer bulkhead obscures the trucker's vision, he is unable to see over his right shoulder toward approaching traffic. Since the roadway was clear when he first started to negotiate the turn, the driver erroneously assumes it's still clear. However, the trucker must realize how long this exercise will take. If he stopped in the crossover, moved forward and stopped again, the procedure to this point could take 10-12 seconds. A car traveling at 55 mph will travel from 808 to 970 feet in that time frame. If there are any curves, hills, trees in the median, etc., it is quite possible any traffic was out of sight when the truck's maneuver began.

In this case, the motorist does not see any headlights of the tractor for they are pointed the other way. The sides of trailers normally have but three lamps and three reflectors. In the example, the rear markers are in the median and the front ones are off the road to the right. Only the center light and reflector are visible.

Now let's return to driver expectation. As you drive along the only thing in your line-of-sight is the single middle amber light. As you have no reason to expect an amber light ahead of you, you may SEE the light, but do not PERCEIVE it as a hazard. It could simply be a sodium-vapor light off in the distance. Should there be city lights or other illumination down the road, the trailer will be but a black silhouette in the darkness.

At some point in time, the motorist may discern the trailer. If he does, it will take a while for it to "sink in." If the driver does perceive the trailer, his mind races as to what to do about it. Since the entire roadway is blocked, swerving is out of the question and the only option left is to lock the brakes. In most cases there are no skidmarks so we never know whether the driver ever perceived the trailer and if he did, he was too close to leave any skidmarks.

In a few cases, you may find that the underriding motorist had been drinking or influenced by some other drug. Granted, drugs dull the senses, interferes with judgement which usually increases perception time. However, many such accident cases involved "normal" drivers. Quite a few have been elderly (and we must realize the night-time acuity of vision of the chronologically gifted isn't what it used to be) but trailer underride knows no bounds when it comes to age, mentality, sex or other differences in motorists.

WHAT CAN BE DONE ABOUT IT?

The trucking industry has known about this problem for years. I have personally been involved in accident cases that have gone into litigation and the awards are often substantial. And word of multi-million dollar lawsuits spreads rapidly. Brian O'Neill, president of the Insurance Institute for Highway Safety (IIHS), in a statement before a Select Committee in the U.S. House of Representatives, addressed the issue of tractor/trailer conspicuity in general and truck underride in particular. He was speaking mainly about rear-end collisions, but in the IIHS "Status Report" (December 31, 1991) side impacts are mentioned:

"Crashes in which large truck trailers are struck in the side or rear could be reduced by 15 percent if the vehicles were more visible in the dark and in bad weather, estimates the National Highway Traffic Safety Administration (NHTSA). The agency is proposing that manufacturers install reflective patterns on trailers to 'help motorists judge size, shape, and distance.'

"The proposed conspicuity rule requires manufacturers to install 'retroreflective sheeting or reflex reflectors' on the sides and rear of trailers with a width of 80 inches or more and a weight rating of more than 10,000 pounds."

[Note: Since this article was originally published, the proposal became effective for trailers manufactured on or after December 1, 1993.]

For those of you interested in reading more about the Federal Motor Vehicle Safety Standard (FMVSS) - and to see illustrations showing how trailers should be marked, I refer you to the Department of Transportation's 49 CFR Part 571, Docket No. 80-9; Notice 4; RIN 2127-AA12. It is subtitled "Lamps, Reflective Devices, and Associated Equipment." Contact NHTSA's Docket Section, Room 5109, NASSIF Bldg., 400 7th St., S.W., Washington, D.C. 20590; (202) 366-6346.

As stated earlier, the problem has been known in the trucking community for some time. Quoting the Federal Register, Vol. 56, No. 233, "On May 27, 1980, the agency [NHTSA] issued [a request] for comments on methods to reduce such collisions by improving the conspicuity of large commercial vehicles that could lead to the issuance of a proposal. Forty-two comments were received, most of which favored the concept."

All of this rule-making seems to be aimed at manufacturers. But what of the millions of tractor/trailer combinations already on the road? A number of firms, such as Avery, Reflexit, and most notably 3M, have developed after-market products to enhance the conspicuity of semi trailers.

A spokesperson with 3M's Commercial Graphics Division advised me that they have developed Scotchlite(tm) Diamond Grade Conspicuity Sheeting, Series 980. This adhesive tape, when applied to existing trailers, has a "minimum 600 candlepower brightness; 900 candlepower typical." It reflects to near 90-degrees and has a seven year performance life. The tape comes in 2", 3" and 4" widths and is easy to apply (designed for flat surfaces, but will apply over rivets if cut out).

This isn't merely "shiny tape." According to 3M's "Product Bulletin 980", "This highly retroreflective sheeting consists of prismatic lenses formed in a durable transparent resin, sealed with a white synthetic film and backed with an aggressive pressure sensitive adhesive. . .."

In February (1992), I spoke with Ron Harold, President of Tennessee Truck Lines, Inc. His company has 500 semi trailers each of which is equipped with 3M's Scotchlite tape. He advised the 2" tape runs about $1.20 per foot and "is almost as effective" as the 4" tape. Mr. Harold told me that it costs about $150 to outfit one trailer which amounts to $75,000 for the entire fleet. Sounds expensive, but it is more than offset in a single lawsuit that could cost many millions of dollars.

Further, Mr. Harold and I discussed the insurance angle. When asked if his insurance rates were less because he used the tape, he said once you demonstrate decreased accident frequency [after the tape has been applied], your rates decrease accordingly.

Another trucking company representative stated that after using reflective material for eight years they had reduced accident claims and lower insurance rates to prove it.

It may sound like I'm selling 3M products. What I am selling is safety. As accident investigators and reconstructionists, you should promote safety at every opportunity. When working night-time trailer underride accidents pay particular notice to the rear and side markings on the involved trailer. Take photographs with and without a flash attachment. How much "normal traffic" light is reflected by the trailer?

A lot of us use the typical one second for perception and three-quarters of a second for reaction and then so many feet to slide to a stop. But, does this work for a night-time driving situation when you have wet pavement and an UNEXPECTED FIXED OBJECT? A driver may see and eventually perceive a trailer in front of him, but it's going to take a lot longer before he realizes IT ISN'T MOVING! One "decision sight-distance time model" indicates that at 30 MPH it takes 10.5 seconds and 460 feet from the time an "unexpected fixed object" becomes visible for the driver to "see" it, recognize hazard, decide on action, initiate action, and complete maneuver. At 60 MPH, the distance could be 1275 feet. This of course does not involve hitting the brakes, but in steering around the hazard.

At least on the open road, drivers expect to come up behind the back of semitrailers sooner or later. However, they would not reasonably expect to find an object the size of a small house crosswise in the road ahead.

As accident investigators, keep in mind the safety standard. Quite often, officers fault a driver who, from all outward appearances, simply runs into the back or side of a stationary (or nearly stationary) vehicle. After all, the investigation indicates the struck vehicle had the DOT required lamps and reflectors. Even if the trailer doesn't come under the FMVSS rule, the industry is aware not only of the proposed legislation but of the problem of trailer conspicuity.

In a rear-underride case, note first whether the trailer had a properly installed DOT bumper (when required). If not, you can cite the trucker as well as his company. Secondly, note if the bumper conforms to code (many do not extend far enough toward the sides of the trailer). Third, did the bumper collapse (it's supposed to be "substantial)?

Besides installing reflective materials to the trailers, trucking companies should school its drivers regarding the potentially dangerous practice of backing across roadways and making U-Turns at night. Every driver should be aware of the capabilities of the truck, its total length, its acceleration capacity, the amount of time it will take to make particular maneuvers, etc.

Many trucking firms offer their drivers no training whatsoever. Management often responds by saying they hired a supposedly "professional driver" who should know all the rules. However, it is incumbent on the company to ascertain the level of proficiency and knowledge a particular driver has of the equipment he or she will be operating.

Granted, it may ultimately be up to a jury to decide proximate cause or percentage of fault; however, you as the initial investigator can assist the trier of fact if you have done not just a report but a thorough investigation.

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Trailer Underride: Conspicuity, Human Factors and Rear Bumpers

by Joseph E. Badger

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Page numbers have been omitted from the following table because much of the text has been edited out in this electronic version. Also, throughout the text you'll see references to figures and diagrams. These are available only in the published version.

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PART I

(This part is unchanged from the 1995 edition. What follows here is condensed from the published version.)

It was a dark and foggy night . . . . A tractor-trailer rumbled along a lonely stretch of State Road 29. The rig burst through patches of mist hanging over the highway and rolled toward the outskirts of a town. The cargo, destined for a nearby factory, rested within the walls of the dirty, white trailer. Perhaps because visibility was reduced the truck driver drove by his destination and out of the small community; perhaps his mind was on other things. When he realized his mistake, the only thing to do was to turn around and head back.

Meanwhile, somewhere out there, two motorists left their respective homes and headed toward town for work. The lead driver, a male in a Bronco, didn't know the woman behind him in an Oldsmobile station wagon. Each driver was aware of the others vehicle only in the sense that any driver is conscious of other traffic on the road.

The trucker, upset with himself for missing his exit, cursed under his breath as he looked for a good place to turn his rig around. Well, no sense taking all night, why not just turn around at the next available place? It so happened that the first convenient spot was an intersection with a little county road, nestled between a couple of knolls. Impossible to make a U-turn, the truck driver knew he could shave a few minutes off his already overdue trip if he (1) stopped along the edge of the highway, (2) pulled onto the shoulder, (3) dropped into reverse gear, (4) cranked the rig across the highway into one of the legs of the county road, and (5) headed back to town.

The trucker had pulled slightly onto the right shoulder and was ready to make his next move when he caught the glimmer of headlights somewhere in the distance. He figured he could back across the roadway before the oncoming traffic reached the intersection. What he didn't figure was the amount of time it takes to make such a maneuver. As the Bronco approached, the trailer bisected the highway at a 45-degree angle. Behind the Bronco, the Oldsmobile driver wondered about the thick patch of fog up ahead. Suddenly the Bronco smashed into that "fog." The Olds driver, stopping just in time, witnessed a case of trailer underride.

DRIVER EXPECTATION

Everyone knows a 48-foot-long white semitrailer should be easy to see. Considering that it is 13 feet high and nearly the size of a small house and the trailer had all the proper lights required by the Department of Transportation (DOT), how could the Bronco driver miss seeing it? The operative word is see. We will never know what that driver saw because he didn't live to tell his story.

Another reason is that crosswise trailers are difficult, if not impossible, to identify or perceive because the headlights of the tractor appear to be on a vehicle that is traveling where its supposed to be in the opposing lane. The closer the oncoming motorist gets to the tractor, the brighter is the glare from the tractors lights and the more difficult it is for the motorist to see through the light wall. (See Photo 1.)

Federal Motor Carrier Safety Regulation §393.14 requires one amber reflector and marker light at the center of the trailers side and similar devices on the side at the front. Rearward reflectors and markers need to be red. Although the trailer in this case had all these devices and the tractors headlights pointed away from the traffic, another problem confronted the motorist.

WHAT ABOUT BACKLIGHTING?

One may wonder about the backlighting presented by the truck stop from which the trucker recently left. Typically, people think that ambient lights on the other side of an angled tractor-trailer would help highlight the truck as it sits across the highway. It just doesn't work that way. Backlighting turns a tractor-trailer into a silhouette. A silhouette, by definition, is an outline that appears dark against a light background. A black silhouette at night on a dark road where there is no traffic does not register in the minds of motorists. Its like a black hole.

As it happened, the motorist drove straight into and under the semi-trailer. The car and most of the lone occupant came out the other side. And there were no pre-collision skidmarks.

IS TRAILER UNDERRIDE REALLY A PROBLEM?

How much of a problem is trailer underride? Accident data collected from April 1979 to May 1980 was published in Results of the NASS Truck Underride Special Study. According to that study, 244 truck accidents with underride potential were analyzed. The study reported:

"Investigation determined that 56 of these were underrides with passenger compartment intrusion (PCI). Of the entire set these PCI accidents were most highly associated with severe injury (25% of the non-truck occupants were severely injured). . . NASS provides a national estimate of underride accidents for the study period. NASS estimates there were approximately 9,000 truck underride accidents with 5,000 involving PCI. Of the latter almost all (97%) involved some injury."

SEMITRAILER CONSPICUITY

Can anything help -- other than training and education -- to stem the statistics of side trailer underride? Most vision experts have long argued that the currently mandated side marker lamps are ineffective or inadequate to forestall this type of accident. Generally, trailers angled across roadways severely limit the amount of reflected or direct light that reaches oncoming drivers.

In their paper "Underride Accidents: Headlights, Glare, and Nighttime Visibility," presented many years ago at Safety Conference IV in Montreal, Messrs. Douglas R. Brown, Jeffrey C. Bookwalter (both of Systems Engineering Associates, Worthington, Ohio) and Dennis Guenther (Department of Mechanical Engineering, Ohio State University) conclude: Headlight glare plays a major role . . . because the glare increases perception time." They add: "The side marker lights are not adequate warning devices because they are not associated with a trailer, not because they cannot be seen at a distance."

MARKER LAMP EFFECTIVENESS

As noted in some of the cases, even when headlight glare is not a factor, side marker lamps are deficient in trailer identification or recognition. Before a motorist can react to a hazard, the hazard must be perceived for what it is.

Consider nighttime vision acuity and tractor-trailer conspicuity. The field of optometry has done about all it can to improve eyesight; therefore, responsibility lies with making trailers more visible. Bigger lamps? More candlepower? Additional lighting? Perhaps. Advances are being made toward enhancing trailer conspicuity.

The article "Trailer Underride: The Almost Always Fatal Collision" (LAW and ORDER, May 1988) mentions that headlights, on dim, "probably allow the driver to see about 200 feet away." A vehicle at 55 miles an hour will cover 200 feet in about 2.5 seconds. It may take the entire 2.5 seconds to see, identify, and perceive a hazard. There is no time left even for reaction, let alone the time required to come to a stop. Moreover, further vision studies suggest that 175 feet is a more likely distance (with headlights on dim) for drivers to distinguish an object on a dark road. According to a University of Michigan study, a driver using high beams at night can see a pedestrian clad in white from about 300 feet. If the pedestrian wears dark clothing and the driver uses low-beam headlights, visibility drops to less than 100 feet.

As discussed in "Trailer Underride Revisited" (LAW and ORDER, August 1992), the 3M Company addresses conspicuity in their booklet "Conspicuous Problems . . . Conspicuous Solutions." They define conspicuity as "the degree of observability of an object. The ease by which an object can be perceived." According to 3M, "Drivers recognize objects by five visual cues of conspicuity: Detection, Estimate of Distance, Determination of Length, Assessment of Shape, and Definition of Objects Relative Position."

MOTORISTS JUDGEMENT OF TIME AND DISTANCE

There is a situation in which side underride accidents may occur where the motorist, rather than the truck driver, bears the greater responsibility in avoiding a collision. The accidents often occur at night but are common enough also in broad daylight. Picture a tractor-trailer enroute north on a four-lane undivided highway. The trucker wants to turn left at an intersection. A car is approaching from the north at 55 miles per hour. The trucker begins his turn when the car is one-tenth of a mile (528 feet) from the intersection. Can he complete his turn before the car gets there?

The rig will travel 84 feet from the moment the turn is begun until the trailer is clear. This includes the distance the rear of the trailer will still have to cover to reach the intersection and then angle across the two 12-foot lanes. The trucker will not stop before turning. At an average speed of 10 miles per hour through the intersection, it will require just under six seconds to complete the maneuver.

Since at 55 miles per hour (80.85 feet per second) the approaching car will cover only 485 feet in a full six seconds, the rig will clear the intersection in time. However, if the semi had been loaded to capacity and the trucker had stopped before starting his turn, he might have needed some 11 seconds to accelerate and get his rig in the clear. The car, approaching at a steady 55 miles per hour, would have had to be at least 890 feet away to avoid a collision.

As motorists drive down certain avenues and highways at night, they are confronted with all kinds of distractions by way of lights. There are overhead street lights, neon sign lights, traffic lights, clearance lights on trucks, oncoming headlights and fog lights, taillights and brake lights, and billboard lights. There are red lights, green lights, amber lights . . . lights of about any color and hue you can think of. If a car in front of a motorist caught up in this light show suddenly swerves for whatever reason, the motorist may be inclined to swerve too, just in case there is something there to miss.

Tractor-trailers, especially double-bottoms, are about the size of a house when viewed from the side. Yet without lights or a considerable amount of reflectorized material, these objects, when blocking the road, are nearly impossible to discern. Motorists have difficulty discriminating dark-appearing objects from grayish-black backgrounds. It isn't that the motorists cannot see the objects but rather that they need time and distance to identify and recognize the objects as hazards and lacking this, may not be able to stop their vehicle without having a collision. Nor are the motorists alone. Truckers at the wheel of a tractor sometimes run into such objects too.

MARKER LAMPS

Drivers also run into properly lighted trailers. One might question, however, just how properly lighted are some of these trailers. Their running lights may meet all the DOT specifications, but truck drivers doing routine checks of tires, hoses, lamps, etc. do not generally mess with those top marker lights; they are 13 feet from the ground. How often does anyone clean them? Over time, even lenses at the bed of the trailer -- just three and one-half feet from the pavement and easy to wipe off -- get dirty. What were once bright red lights become dim pink dots in the distance to a motorist approaching from the rear.

SPEED DETERMINATION OF AN UNDERRIDING VEHICLE

Speed is usually an issue, but it is difficult to determine impact speeds in underride cases. When a vehicle has had its hood, its A-pillars, and its top sheared off, an impact speed estimate is speculative at best. However, if instead of underriding the trailer, the vehicle has struck the drive wheels of the tractor or the wheels of the trailer, it might be possible to calculate energy losses based on crush. The energy consumed can then be translated into speed by using any number of computer programs or this may be done the old-fashioned way with complex equations and a hand-held calculator. Still, some subjectivity remains.

The reason it is difficult, if not impossible, to calculate the speed of a vehicle that underrides a trailer is, according to the NASS study, that "a step damage pattern is believed to result. Here two areas of the vehicle front, one above and one below the beltline, are impacted as a result of one force acting on an

overhanging structure. Unlike other CDC [Collision Deformation Classification] damage codes, this one [with step damage] uniquely identifies the underride."

Part II of this treatise, which follows, was written in 1998 and, with the more recent information available, expands on a number of the points discussed in Part I, written earlier, and introduces several new ideas. As the information contained in Part I retains its relevance and usefulness, Part I remains unchanged in content from the 1995 edition.

PART II

[This is a condensed version of the published manuscript.]

DOES THE NEW FMVSS MANDATE AN ADEQUATE UNDERRIDE GUARD?

Effective January 26,1998, a new Federal Motor Vehicle Safety Standard governs new trailers and semitrailers at or above a Gross Vehicle Weight Rating (GVWR) of 10,000 pounds. This regulation mandates requirements for rear underride protection guards (a.k.a. ICC or DOT bumpers).

Section 393.86, titled "Rear impact guards and rear end protection," states: "Each trailer and semitrailer with a gross vehicle weight rating of 4,536 kg (10,000 pounds) or more, and manufactured on or after January 26,1998, must be equipped with rear impact guard that meets the requirements of FMVSS No. 233 (49 CFR 571.223) in effect at the time the vehicle was manufactured."

Up to that date, the lower horizontal member of the rear underride guard need not be lower than 30 inches (762 mm). From that date forward, however, the height (ground clearance) must be no higher than 22 inches (560 mm). Moreover, the guard must extend to within four inches (100 mm) of the sides of the trailer, with exceptions for rounded guard ends, an d must be as close to the rear of the vehicle as possible (within a 12-inch zone in front of or behind the rear of the trailer). As noted in the Federal Register of January 24, 1996 (Volume 61, Number 16), "Using rounded guard ends will diminish the hooking potential of the guards when the trailer is turning sharply. Guard ends that are rounded upward and attached to the vehicle may add strength to the horizontal member near the side extremity of the vehicle."

Excluded from the new regulation are single unit trucks, truck tractors, pole trailers, low chassis and special purpose vehicles, and "wheels-back" vehicles. The latter being trailers and semitrailers, their rear axle is so far to the rear as to put the tires within 12 inches of the back of the trailer. Consumer safety groups -- and the general public -- are opposed to one or more of these exclusions, especially for the single unit trucks, such as some dump trucks.

There is also a problem with the stipulated 22-inch clearance. The top of nearly all automobile bumpers is less than 22 inches from the ground. On large automobiles such as the Lincoln Town Car and Oldsmobile Custom Cruiser, the bumper's top is right at 22 inches from the ground. The 22-inch ground clearance stipulation will certainly prove to be too high as the automotive industry designs and introduces hybrid fuel-efficient electric-gasoline cars. Along with being up to 50% lighter than today's automobiles, these cars will be even lower to the ground, with plastic bodies forthcoming.

Stephen G. Hadley, Coordinator of the Underride Network (a worldwide non-profit volunteer organization dedicated to educating the public about and assisting/serving the victims of truck and trailer underride crashes), notes that "our government knew this when it performed its crash tests for the new, more substantial guard. And with a 10+ year turnaround for a new guard to filter through the fleet, these [lighter cars] might be the majority cars on the highway during this substandard guard's reign."

Part of the underride problem is with law enforcement. In many municipalities, local police and sheriff departments get very little -- if any -- training regarding heavy truck enforcement. Many state police and highway patrol agencies have specialized personnel who investigate commercial vehicle accidents but even some state units know very little (or seem to care little) about underride guards.

Substantial rear underride guards have been available for some time. One called the RP 92-94 (RP = Recommended Practice) will withstand more force than many underride guards seen on the highway today. To ascertain the energy-absorption capabilities of the RP 92-94, a staged crash was undertaken at the Law Enforcement & Security Training Division of the Texas Engineering Service (TEEX) at Texas A&M University. This staged event took place during CRASH '97, a seminar for accident reconstructionists.

Staging personnel put a 4,280-lb 1992 Ford Explorer at nearly 30 mph (28.8 mph) into a 45,000-lb tractor-semitrailer outfitted with an RP 92-94 bumper. The 1986 Great Dane refrigerated trailer was specially loaded with one 7,450-lb concrete block, one 2,720-lb concrete block, and four 80-lb bags of cement. The bumper indeed collapsed, but only partially. It allowed the bullet vehicle to "ride down," thereby preventing intrusion or penetration into the Ford's occupant compartment -- view of Ford Explorer behind a semitrailer, post-crash). A second staged crash, utilizing a rear underride device known as the "Georgia bumper," was carried out a few days later.

DUMP TRUCKS PRESENT A SPECIAL PROBLEM

Another case involved a large dump truck the rear axle of which was well forward of the back of the bed. There never was any sort of rear underride guard on the truck at all. When a vehicle underrode the back of the bed, investigating officers did not consider the absence of the bumper as a causative circumstance. Dump trucks such as the one shown weigh about 18 tons empty. The dump bed (not counting the extension over the cab) is about 26 feet long and can carry over 42 tons of coal. The legal GVW limit in Kentucky is 90,000 pounds. If such trucks were designed and built to haul the legal limit, the bed would need to be only 16-3/4 feet long -- or ten feet shorter! Since the danger zone behind the rear tires is about six feet, a shorter bed would reduce the overhang considerably and thereby lessen the danger.

Many trucking companies insinuate that it wasn't just inattention but a matter of the motorist falling asleep. Left out of the equation, however, is that many cars are underriding semitrailers that are either stopped or moving significantly slower than normal, and remarkably slower than other traffic.

It is not a case of 90-mph cars running into the rear of 65-mph semis. What happens is that the tractor-semitrailers -- often loaded, which slows their acceleration rates even more -- merge too slowly into traffic. Such trailers get rear-ended when traveling 25-35 mph by unsuspecting motorists who may see the back of the trailer but appreciate neither their closing speed nor the fact that the rig is barely moving compared to other traffic. In a technical report for Transport Canada titled "The Perceptual Basis Of Heavy Vehicle Conspicuity And The Role Of Retroreflective Materials In Increasing Driver Decision Sight Distances," Brian Tansley and Will Petrusic of Carleton University's Psychology Department stated it this way: "The dynamic aspect of control of a moving vehicle involves the visual perception of the driver's own movement relative to the roadway and of the movement of other vehicles relative to his/her own."

Precollision skidmarks are rare. Occasionally investigators will find some, but the marks are usually not very long. This obviously means that by the time the motorist realized that a semi posed a problem, he or she was far enough back to get on the brakes, but too close to skid to a stop. Nearly every underride case occurs at night. Once in a while, though, such instances happen in broad daylight. When the big rigs go through crossovers on four-lane highways, they can usually be seen and recognized from a considerable distance. In some cases there will be lots of skidmarks.

Several years ago the 3M company produced a video titled "The Beauty of Conspicuity." It contained a section on Decision Sight Distance explaining that the Federal Highway Weight Administration (FHWA) commissioned a company called Biotechnology to study time/distance situations regarding underride accidents. The study results show that a driver "with average reflexes, eyesight, decisiveness and sobriety, driving an average car" [at 60 miles per hour] will take almost three seconds to see and recognize a hazard, almost seven seconds to decide on a course of action, and almost 4.5 seconds to complete an avoidance maneuver. This is a perception/reaction time (PRT) several times greater than that generally accepted by "vision experts."

In side-underride cases, one party always argues that the trailer came equipped with all the necessary lights. The three obligatory lights along the side of a semitrailer are indeed all that are "required." However, they are merely three dots of light seemingly suspended four feet in the air. They do not necessarily connect to anything. Flatbed trailers are especially dangerous because motorists can see both over and under the trailer and those obligatory lights may appear to be way off in the distance.

TRAILERS IN SOME COUNTRIES ALSO HAVE SIDEGUARDS

In Japan and Europe, because of the immense amount of bicycle and motor scooter traffic, semitrailers have side underride guards. These may not prevent a car at 55-mph from going partially beneath the side of a semitrailer, but in the typical T-bone side-underride case, sideguards braced with lateral beams allow the car to "ride down" the collision. Sideguards are placed on tanker trucks as well.

Sideguards are beneficial in situations on 4-lane highways where a tractor-semitrailer and an automobile are fairly parallel, one overtaking the other and the car is in one of the truck's "blind spots" when the trucker changes lanes. Without the presence of the side- guards, the car would become engulfed beneath the bed of the semitrailer. Sideguards, however, deflect the car away and only minor sideswipe damage results. This is obviously preferable to having the car demolished and its occupants perhaps injured or killed. Likewise, when the big rigs make right turns, they usually make a wide sweep, first to the left, then to the right. An unsuspecting motorist, thinking the rig is making a left turn, starts to pass on the right only to become swallowed up by the trailer.

U.S. trailer manufacturers and trucking companies have long been aware of the protection and safety benefits that side rails provide but have successfully defeated any legislation mandating the implementation of the devices.

In some recent crash tests, it was shown that side rails indeed prevent cars from underriding even at nearly 90 degrees.

MORE ON REAR BUMPERS

Heavy vehicle underride has become such a worldwide problem that a symposium called "SAE Heavy Vehicle Underride Protection TOPTEC" took place in April 1997 in Palm Springs, California. Byron Bloch, an independent consultant in auto safety design and crashworthiness, offered at his presentation that "The new NHTSA safety standard for a rear underride protection guard is certainly better than the obsolete and ineffective ICC-regulation rear bumper that began back in 1953." "But no," he said, referring to the new standard, "it's not good enough."

Bloch explained that the vast majority of the obsolete ICC rear bumpers that you see hanging down at the rear of trucks and trailers are too high off the ground (typically in the 24 to 28-inch range), are too narrow across the rear, and are too weak."

Many such bumpers are bent, twisted, rusted, and have no reflective tape. There is a device called a "dock lock." This is a mechanism affixed usually to a building or loading platform to which truckers can fasten their trailers after backing them up to the platform. It secures the trailer during the loading or unloading process, especially when forklifts run in and out of the trailer cross the rear door sill. Backing into those devices can damage and thereby weaken the underride guard. Simply backing into the loading docks themselves may incapacitate the ICC bumper.

IN HOLLAND, AUSTRALIA AND ELSEWHERE

[Much of this section has been omitted from this electronic version.]
On the lighter side for a moment, George Bernard Shaw once wrote:
"Britain and America are two countries separated by the same language." This becomes evident when one reads a British publication titled "The Law and Its Meaning" and consolidating the statutory

instruments in the exact terms of what the regulations say. Regarding underrun bumpers, there are exemptions. The vehicles most commonly exempted in Britain are (transcribed verbatim): "Fire engines, Tractive units of artics, Tippers and gritters, Car or caravan transporters, Pole trailers, Concrete mixers and agitators, Bare chassis (for most practical purposes), and Inset tail-lifts at least a metre deep, integral with the body."

The latter type includes, according to Police Constable Andrew Clay of West Sussex, England, "a brick lorry that has a small fork lift truck attached to the back on a tail lift that is employed only during loading/unloading."

My personal favorites are tippers and gritters. I thought tippers might be British for dump trucks, but no. Clay advises, "Tippers are usually eight-wheel twin steer 32 tonne rigid goods vehicles that take or remove earth or aggregate to or from building sites or landfill sites."

"Gritters," Clay adds, "are usually a 24-tonne chassis to which a hopper is added to the back and then two spinning spreaders disperse grit onto the road surface from the rear of the vehicle . . . ." Something we Americans would call a salt spreader or snow-removal truck.

Returning to a more serious vein, countries around the world are becoming concerned with the instances of underride. George Rechnitzer of Monash University's Accident Research Centre in Clayton, Victoria, Australia, states, "Crashes involving heavy vehicles and other road users are recognised internationally to be a significant contributor to the total number of people killed or seriously injured in road crashes." At the 15th International Technical Conference on the Enhanced Safety of Vehicles, Rechnitzer made a presentation on "Development and Testing of Energy Absorbing Rear Underrun Barriers for Heavy Vehicles."

In his presentation Rechnitzer said, "Rear underrun crashes are a particularly severe crash type because the floor structure of most heavy vehicles is above bonnet height. Cars can run under this structure (e.g., the tray of a rigid truck) with the tray penetrating through the car's windscreen pillars and into the passenger compartment. The usual occupant protection features built in cars such as seat belts, airbags, crush zones are bypassed and ineffective in this crash type." In a comprehensive study titled "Truck Involved Crash Study: Report on Fatal and Injury Crashes of Cars Into the Rear of Trucks," (May 1991), Rechnitzer and Foong Cee Wai further discuss this and several other issues.

As a partial solution, Rechnitzer adds, "An effective means of preventing underrun lies in adding a frame structure to the rear of the truck which is of sufficient structural strength and geometry to engage the front structure of a car . . . .

"Most heavy vehicles," he goes on, "do have some sort of barrier already, but these are typically poorly designed and quite ineffective. Rear underrun crashes in Australia account for some 15 or so people killed every year, and some hundreds injured." Specializing in vehicle crashworthiness and occupational health and safety issues, Mr. Rechnitzer documented a "Truck Involved Crash Study" which included a detailed literature review and detailed investigations of over 52 crashes involving 45 fatalities, including crashes of trams and buses with cars. "The study has identified that design changes are both feasible and effective, and that the frontal, side, and rear design of trucks can be significantly improved to reduce the harm potential in crashes involving other road users." This is in line with European findings, according to Rechnitzer, which countered commonly held notions that the main problem was the mass of the truck -- a factor not readily amenable to change.

RETROREFLECTIVE MATERIALS

After undertaking pertinent research, another Canadian, Eric Hildebrand, along with Peter Fullarton, both from the University of New Brunswick, prepared a paper with the title "Effectiveness of heavy truck conspicuity treatments under different weather conditions" for Proceedings of the Canadian

Multidisciplinary Road Safety Commission X, June 8-11,1997, Toronto, Ontario. That study revealed: "All retroreflective tape treatments which were tested provided significant increases in visibility thresholds relative to an untaped trailer under each weather condition except fog . . . . The presence of fog decreased the visibility thresholds by as much as 90 percent for these field tests. The rear of the trailer seems to exhibit more of a relative reduction in visibility threshold than the side as weather conditions deteriorate. Nevertheless, even under rain and snowy weather conditions, a substantial benefit is derived by using retroreflective tape."

Hildebrand and Fullarton found that the rear "full white outline" tape configuration was found to be most effective under all weather conditions but that no one pattern/color was found to be more effective given specific weather conditions. "Full" or solid white tape was found most effective for the side of the trailer under all weather conditions except rain.

The study noted that "The Canadian standard allows the substitution of solid white in favour of the alternating red/white tape, for either the rear or sides," and that "new Canadian legislation also permits the use of yellow and alternating yellow/white tape."

REAR BUMPERS AGAIN AND LIGHTING

RETROREFLECTIVE TAPE AND CONSPICUITY

[The above sections have been omitted from this electronic version.]

In closing -- accident investigators, reconstructionists and the motoring public must be aware of the possibility of slow-moving rigs on our highways and of the fact that heavy commercial vehicles occasionally block roads. They should also be cognizant that marker lamps do get dirty and that drivers might not always associate an occasional dot of light or two as being on something the size of a house that's sitting in their lane of travel.