

The Effectiveness of Retroreflective Tape on Heavy Trailers

Christina Morgan

Abstract

This report evaluates the effectiveness of retroreflective tape in enhancing the visibility of heavy trailers and reducing side and rear impacts by other vehicles into these trailers during dark conditions. It is based on a statistical analysis of 10,959 crash cases investigated by the Florida Highway Patrol and the Pennsylvania State Police in 1997 - 1999.

The tape is quite effective. It reduced side and rear impacts into trailers, in dark conditions (including "dark-not-lighted," "dark-lighted," "dawn," and "dusk") by 29 percent. In "dark-not-lighted" conditions, the tape reduced side and rear impact crashes by 41 percent. Tape is especially effective in reducing injury crashes. In dark conditions, it reduced side and rear impacts that resulted in fatalities or injuries to drivers of any vehicle by 44 percent.

Executive Summary

All heavy trailers manufactured on or after December 1, 1993 must be equipped with red-and-white retroreflective tape, sheeting and/or reflex reflectors around the sides and rear to make them more conspicuous. The National Highway Traffic Safety Administration (NHTSA) established this requirement, with its various options, in December 1992 by amending Federal Motor Vehicle Safety Standard (FMVSS) No. 108, "Lamps, Reflective Devices, and Associated Equipment." However, retroreflective tape has been used almost exclusively for meeting the standard, and it is the subject of this evaluation. Heavy trailers are at least 80 inches wide and have a Gross Vehicle Weight Rating over 10,000 pounds.

The purpose of retroreflective tape is to increase the visibility of heavy trailers to other motorists, especially in the dark. At those times, the tape brightly reflects other motorists' headlights and warns them that they are closing on a heavy trailer. In the dark, without the tape, many trailers do not become visible to other road users until they are dangerously close. The alternating red-and-white pattern flags its bearer as a heavy trailer and at the same time helps other road users gauge their distance and rate of approach. This report evaluates the effectiveness of the tape in reducing side and rear impacts into heavy trailers - primarily in dark conditions where even a vigilant motorist might not see an untreated trailer in time to avoid a crash, and secondarily in daylight, where the tape might alert inattentive drivers that they are approaching a trailer.

In March 1999, the Federal Highway Administration extended the application of this important protection to the entire on-road trailer fleet by directing motor carriers engaged in interstate commerce to retrofit heavy trailers manufactured before December 1993 with tape or reflectors. These older trailers must have some form of conspicuity treatment, by June 1, 2001, in the locations specified by the NHTSA standard for new trailers, except on the rear impact guard. In other words, as of June 2001, almost all heavy trailers on the road will have some form of conspicuity treatment. This Federal Motor Carrier Safety Regulation furthermore gives motor carriers until June 1, 2009 to retire their pre-1993 trailers or retrofit them with treatments that conform exactly to the NHTSA standard (again, with the exception of the rear impact guard).

Since none of NHTSA's crash data at hand (FARS, NASS, or State files) identified whether crash-involved heavy trailers had retroreflective tape, NHTSA worked out agreements with the Florida Highway Patrol (FHP) and the Pennsylvania State Police (PSP) to collect data for this analysis. For a two-year period, each time these agencies investigated a crash involving a tractor-trailer and filed a crash report, they also filled out an "Investigator's Supplementary Truck-Tractor Trailer Accident Report" on every trailer in the crash. The FHP collected 6,095 crash cases from June 1, 1997, through May 31, 1999. The PSP collected 4,864 crash cases from December 1, 1997, through November 30, 1999.

The analysis estimates the reduction of side and rear impacts by other vehicles into tape-equipped trailers in dark conditions - relative to the number that would have been expected if the trailers had not been equipped. It is based on tabulating and statistically analyzing crash involvements of tractor-trailers by three critical parameters: (1) whether or not the trailer is tape-equipped; (2) the light condition - dark (comprising "dark-not-lighted," "dark-lighted," "dawn" and "dusk") vs. daylight; and (3) relevant vs. control-group crash involvements. Relevant crash involvements are those where another vehicle crashed into the side or rear of a heavy trailer, because the tape can help the other driver see and possibly avoid hitting the trailer. The control group consists of single-vehicle crashes of tractor-trailers (where visibility of the tractor-trailer to other road users is not an issue at all) and impacts of the front of the tractor into other vehicles (where conspicuity of the side and rear of the trailer is also not an issue).

The principal conclusion of the study is that retroreflective tape is quite effective, and it significantly reduces side and rear impacts into heavy trailers in the dark. Other findings and conclusions are the following:

ANNUAL BENEFITS OF CONSPICUITY TAPE

- When all heavy trailers have conspicuity tape, the tape will be saving an estimated 191 to 350 lives per year, preventing approximately 3,100 to 5,000 injuries per year, and preventing approximately 7,800 crashes per year, relative to a hypothetical fleet in which none of the trailers have the tape.

CRASH REDUCTIONS BY LIGHTING CONDITIONS

- In dark conditions (combining the subsets of "dark-not-lighted," "dark-lighted," "dawn," and "dusk"), the tape reduces side and rear impacts into heavy trailers by 29 percent. The reduction is statistically significant (confidence bounds: 19 to 39 percent).
- However, the tape is by far the most effective in dark-not-lighted conditions. Here, the tape reduces side and rear impacts into heavy trailers by 41 percent. The reduction is statistically significant (confidence bounds: 31 to 51 percent).
- In dark-lighted, dawn, and dusk conditions, the tape did not significantly reduce crashes. The tape also did not significantly reduce crashes during daylight.

CRASH REDUCTIONS FOR SPECIFIC SUBGROUPS IN DARK CONDITIONS

The effectiveness estimates here are the percentage reductions of various subgroups of the side and rear impacts into heavy trailers in dark conditions. As stated above, tape reduces these crash involvements by 29 percent, overall.

- The tape is especially effective in preventing the more severe crashes, specifically, injury crashes. Impacts resulting in fatal or nonfatal injuries to at least one driver are reduced by 44 percent.
- The tape is more effective when the driver of the impacting vehicle is young. The crash reduction is 44 percent when the driver of the impacting vehicle is 15 to 50 years old, but only 20 percent when that driver is more than 50 years old. A possible explanation of this difference is that older drivers are less able to see, recognize and/or react to the tape in time to avoid hitting the trailer.
- The tape may be somewhat more effective in preventing rear impacts (43 percent) than side impacts (17 percent) into trailers; however, this difference is not consistent in the two states.
- The tape is effective in both clear (28 percent) and rainy/foggy weather conditions (31 percent).
- The tape is especially effective on flatbed trailers (55 percent). These low-profile vehicles must have been especially difficult to see in the dark before they were treated with tape.
- Dirt on the tape significantly diminished its effectiveness in rear impacts. Clean tape reduces rear impacts by 53 percent but dirty tape by only 27 percent.

STATUS OF TAPE IN THE 1997-1999 CRASH DATA

- Almost 50 percent of the pre-standard trailers in the study had retroreflective tape. The retrofit of these older, pre-1993 trailers was already well underway in 1997 - 1999.
- More than 60 percent of the trailers with retroreflective tape had clean tape at the time of the study. About 30 percent of the trailers with tape had some dirt and less than 5 percent had "very dirty" tape.
- About 96 to 99 percent of the retroreflective tape on the side of trailers was intact, while 92 to 95 percent of the tape on the rear of trailers was intact.