

**3M** Science.  
Applied to Life.™

# Safety is easy to see.

Help increase the visibility and safety of your vehicles with 3M™ Conspicuity Markings.



# Set a standard for safety.

When trucks, trailers and other large commercial vehicles are more reflective, they're easier for other drivers to see at a distance—especially at night and in inclement weather—which can lead to fewer crashes, injuries and fatalities on our roads.

An economical way to introduce this enhanced reflectivity on vehicles are conspicuity markings (sometimes called “contour markings”). These retroreflective vehicle safety markings have become a requirement in many countries around the world dating as far back as the early 1990's, and with good reason. With the right application, they can help your vehicle or fleet really stand out at a relatively low cost.

This e-book is intended to help you understand the benefits of retroreflective conspicuity markings—including how they work, why many countries and organizations require them, and what differentiates them—so you can see the bright difference they make for yourself.







# Table of Contents

1   A new perspective on road safety.	4
2   The economic case for conspicuity.	8
3   Regulations around the world.	10
4   The origins of conspicuity technology.	13
5   Better performance from every angle.	14
6   Plan for the road ahead.	15

# A new perspective on road safety.

Decades of research has demonstrated the safety benefits of conspicuity markings.

In jurisdictions where conspicuity markings are applied to vehicles, traffic crashes, injuries and fatality rates improve. In the U.S. alone, truck collisions fell 58% after conspicuity was introduced.<sup>1</sup> And while preventing any type of vehicle collision is important, reducing collisions involving commercial vehicles can be especially valuable because of how their large physical size can impact other smaller vehicles on the road—and their occupants.

Of course, this issue affects virtually every nation that relies heavily on roadway transportation, and the effect that conspicuity markings can have to minimize these types of crashes has been felt in many parts of the world.

## Early recognition is critical.

In 2000, Darmstadt University of Technology in Germany studied 2,216 crashes involving trucks. Of the collisions that occurred during darkness and twilight, 37% of impacts on a truck side and 41% of impacts on the truck rear were caused by the truck not having been recognized in time by other drivers involved in the crashes (see reference on next page).

1. Vector, NHTSA, US DOT FRA, UMTRI, NTSB. Emergency Vehicle Visibility and Conspicuity Study. 1983-2015.

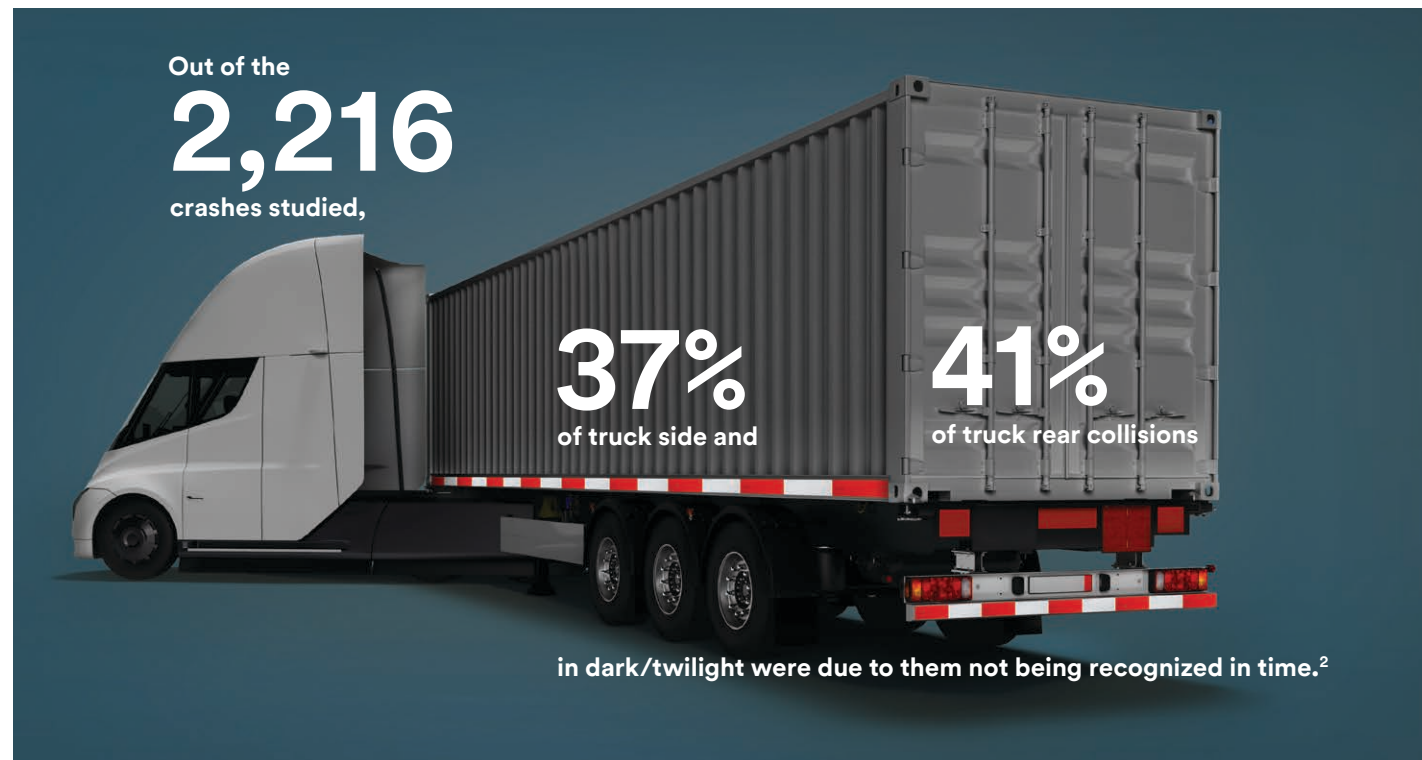


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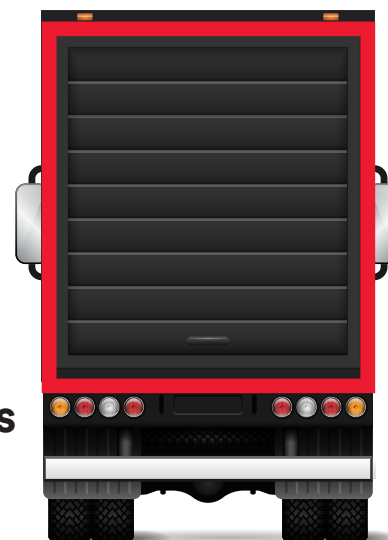
Following this analysis, 1,000 trucks were taken to be studied over a two-year period to evaluate the effectiveness of contour markings to help with early recognition and crash reduction. The results were significant: the control group with no reflective markings had 30 incidents of side or rear collisions at night, whereas only one crash occurred in the test group of trucks with contour markings.<sup>2</sup>



Out of  
**1,000**  
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**30x**  
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at night.<sup>2</sup>



2. Darmstadt University of Technology. Report. 2000.



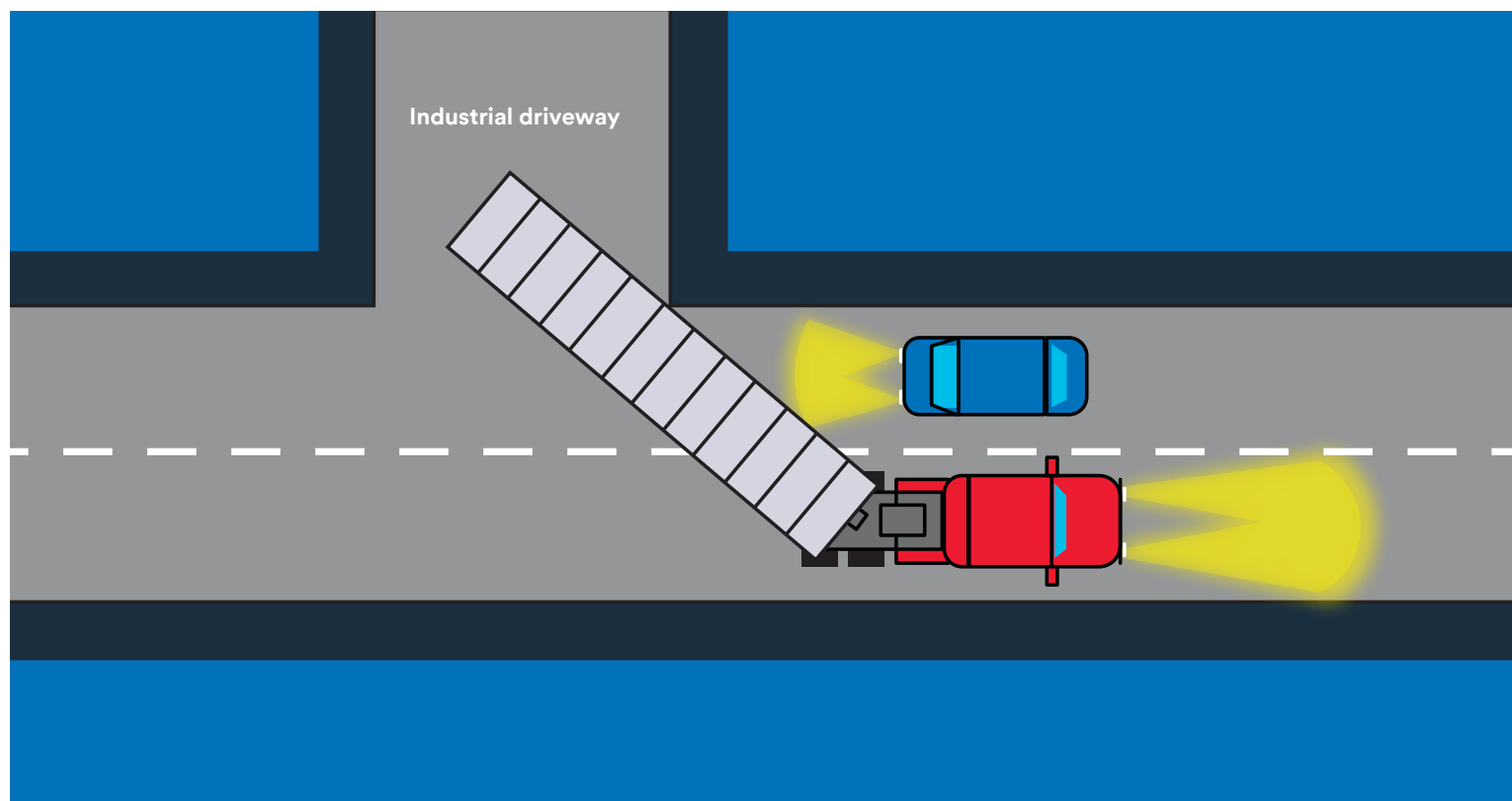
## Large vehicles pose unique road hazards.

Prior to the implementation of broader regulations in the European Union regarding retroreflective markings, the Dutch Transport Safety Board had sought to explore more deeply why semi-truck trailers become involved in so many of these types of crashes.

In 2003, a study was spurred by a specific crash that had occurred several years earlier which illuminated a unique issue associated with these types of vehicles: because they are commonly used for industrial freight

purposes, it's typical for them to move in reverse and be backed up into challenging driveways at various angles—often covering much, if not all of the road.<sup>3</sup>

While simple safety practices were put into place to help reduce these incidents—including avoiding backing up during low-light hours of the day—the study found that adding retroreflective conspicuity markings could additionally reduce the number of crashes involving these vehicles by several hundred annually, resulting in 20 to 30 fewer hospitalizations and 2 to 3 fewer deaths each year.



Retroreflective  
conspicuity could result in  
**20-30**  
fewer hospitalizations

and **2-3**  
fewer deaths annually

See the difference.

[Watch video ►](#)

3. Dutch Transport Safety Board. Accidents involving lorries maneuvering in the dark. 2003.

## Saving lives around the world.

Other studies performed in a variety of countries of different sizes and traffic volumes have yielded similar conclusions on the issue over the years:

In 2001, the National Highway Traffic Safety Administration (NHTSA) published their findings from a three-year study that **conspicuity markings had reduced side and rear impacts** with truck trailers by 29% and fatalities or injuries by 44% in dark conditions.<sup>4</sup>

The European Commission backed TÜV Rheinland Group in Germany published their recommendations in a 2004 report, **concluding that all new vehicles over 3.5 tons should be equipped with conspicuity** markings and that at least 80% of each side should be marked.<sup>5</sup>

While studying both the safety and economic effects of conspicuity markings, Russian transportation safety officials at the Scientific Institute of Motor Transport (NIIAT) saw a staggering **62% reduction in fatalities and a 78% reduction in injuries** over the course of the three-year study.<sup>6</sup>

In Hungary, the Institute of Vehicle Safety studied 1,400 crashes involving cars and trucks, and they concluded that retroreflective markings would **help prevent 600 crashes and up to 65 lives every year.**<sup>7</sup>

**In short, requiring retroreflective conspicuity markings is a relatively small step that can make a big difference for the safety of everyone on the road—and the benefits go beyond just safety.**

4. NHTSA. The Effectiveness of Retroreflective Tape on Heavy Trailers. 2001.

5. TÜV Rheinland Group. Report. 2004.

6. Scientific Institute of Motor Transport. Report. 2005.

7. Hungary Institute of Vehicle Safety Study. Investigation of the Application of Innovative Contour Markings Improving the Conspicuity of Trucks, Report on their Preventive Role during Public Road Accidents, 2009.



# The economic case for conspicuity.

In addition to helping save lives, conspicuity markings can help save money too.

While the safety benefits of conspicuity markings on vehicles like buses, semi-trucks and large vans are easy to see, it's also worth noting how those crash reductions translate into economic value—both for the government and for private entities. While most studies rightly focus and report primarily on the number of injuries and fatalities prevented, the associated reduction in costs for healthcare and the replacement of damaged property can further justify the investment in retroreflective marking solutions and ultimately improve the bottom line.

## The socioeconomics of safety.

In their 2009 study looking at how to advance the state-of-the-art in emergency vehicle visibility, FEMA (U.S. Department of Homeland Security) concluded that a combination of active and passive conspicuity treatments would improve visibility and recognizability of ambulances, patrol cars and fire apparatus.<sup>8</sup> Based on other recent studies, they go on to draw a simple, yet straightforward correlation regarding return on investment: “Recent studies of retroreflective sheeting types in traffic control applications<sup>9,10,11</sup> suggest the cost increase to specify higher-efficiency retroreflective material can be reasonably expected to pay off by reducing crashes under some scenarios.”



**“...the cost increase to specify higher-efficiency retroreflective material can be reasonably expected to pay off by reducing crashes under some scenarios.”**

~FEMA Report, 2009.

8. FEMA. FA-323 Emergency Vehicle Visibility and Conspicuity Study. 2009.
9. Carlson, P.J. (2001). Evaluation of Clearview Alphabet with Microprismatic Retroreflective Sheeting. Texas Transportation Institute. Texas A&M University: College Station, TX. Report# 4049-1. October 2001.
10. Gates, T.J., and Hawkins, H.G. (2004). Effect of higher-conspicuity warning and regulatory signs on driver behavior. Texas Transportation Institute. Texas A&M University: College Station, TX. Report# 0-4271-S.
11. Amjadi, R. (2008). Techbrief: Safety evaluation of increasing retroreflectivity of stop signs. Federal Highway Administration: Washington, DC. Report # FHWA-HRT-08-047. March 2008.

Calculate Potential Savings of Using Conspicuity Tape vs. Impact of Crash.

**Cost Calculator ►**



It stands to reason that having fewer crashes means saving the expense of vehicle damage, driver injuries, downtime for repairs and more. The 2005 study published by NIIAT confirmed the high efficiency of contour marking application due to the substantial decrease of social and economic damages of crashes—and a 2007 report by the Federal Motor Carrier Safety Administration (U.S. DOT) confirmed that the economic impact of even one medium or heavy truck crash can be significant.<sup>12</sup>

Their study concluded that:

The costs per non-fatal injury crash averaged

**\$195,258**

Fatal crashes cost more than any other crashes, coming in at an average of

**\$3,604,518** per crash



And these numbers do not include the variety of potential indirect costs that are difficult to calculate, such as the ongoing mental health care of affected passengers or the public relations impact that can result from any crash involving a truck owned by a prominent company.

These cost savings can be realized on more than just new heavy vehicles hitting the roads too. A 2015 report from the Institute for Road Safety Research in Netherlands concluded that by introducing regulation for the retrofitting of even minimum conspicuity tape requirements on all heavy vehicles, socioeconomic cost savings in both lives and dollars will far outweigh the expense (2:1 benefit:cost ratio).<sup>13</sup>

## Start seeing automated fleets.

As major companies around the world race towards deploying semi-automated commercial vehicle fleets, the cost/benefit breaks down to a relatively simple proposition: investing in new, more expensive driverless and sustainable fleets now should yield long-term cost savings. Between eliminating both the potential for human error on the part of a driver as well as increasing the amount of time a truck can spend on the road, these investments could very well pay off and become the standard—and conspicuity markings are a simple solution to further that goal.

Between the proven visibility and safety benefits, and the relatively low-cost and easy application of conspicuity markings, they are perhaps one of the most compelling additions to a driverless fleet to help protect assets that are likely to be deployed on the road more hours out of the day than ever before.

Cost savings in  
lives | dollars

**2:1**  
Benefit:Cost  
ratio<sup>13</sup>

**Long-term safety  
equals long-term  
savings**

for retrofitting vehicles with  
conspicuity requirements



12. FMCSA. Unit Costs of Medium and Heavy Truck Crashes. March 2007.

13. Stichting Wetenschappelijk Onderzoek Verkeersveiligheid SMOV-rapport R-2015-2. Impact Retrofit ECE104 for NL and EU. 2015.

# Regulations around the world.

Global adoption of conspicuity regulations has been broad but varied over the decades—and more action is needed.

Areas of the world that require vehicle conspicuity do so for a simple reason—it can help save lives. The two most comprehensive standards that have been implemented are FMVSS 108 in the United States (“US DOT-C2”) and UN ECE R104 in Europe.

US (DOT) FMVSS 108



UN ECE R104



## US (DOT-C2) FMVSS 108

### Effective Date:

- ▶ New trailers after December 1, 1993
- ▶ New vehicles/retrofitted older ones after June 1, 2001
- ▶ New truck trailers after July 1, 1997

### Required Vehicles:

- ▶ Gross Vehicle Weight over 4,536 kg (10,000 lbs.)
- ▶ Trailers with an overall width greater than 2,032 mm (80 inches)

### Required Application:

- ▶ Side markings: Average of 50% coverage with Red/White conspicuity markings (not including gaps)
- ▶ Rear markings: Lower rear has 100% stripe coverage with Red/White conspicuity markings

## UN ECE R104

### Effective Date:

- ▶ July 10, 2011 for all vehicles
- ▶ No retrofitting required

### Required Vehicles:

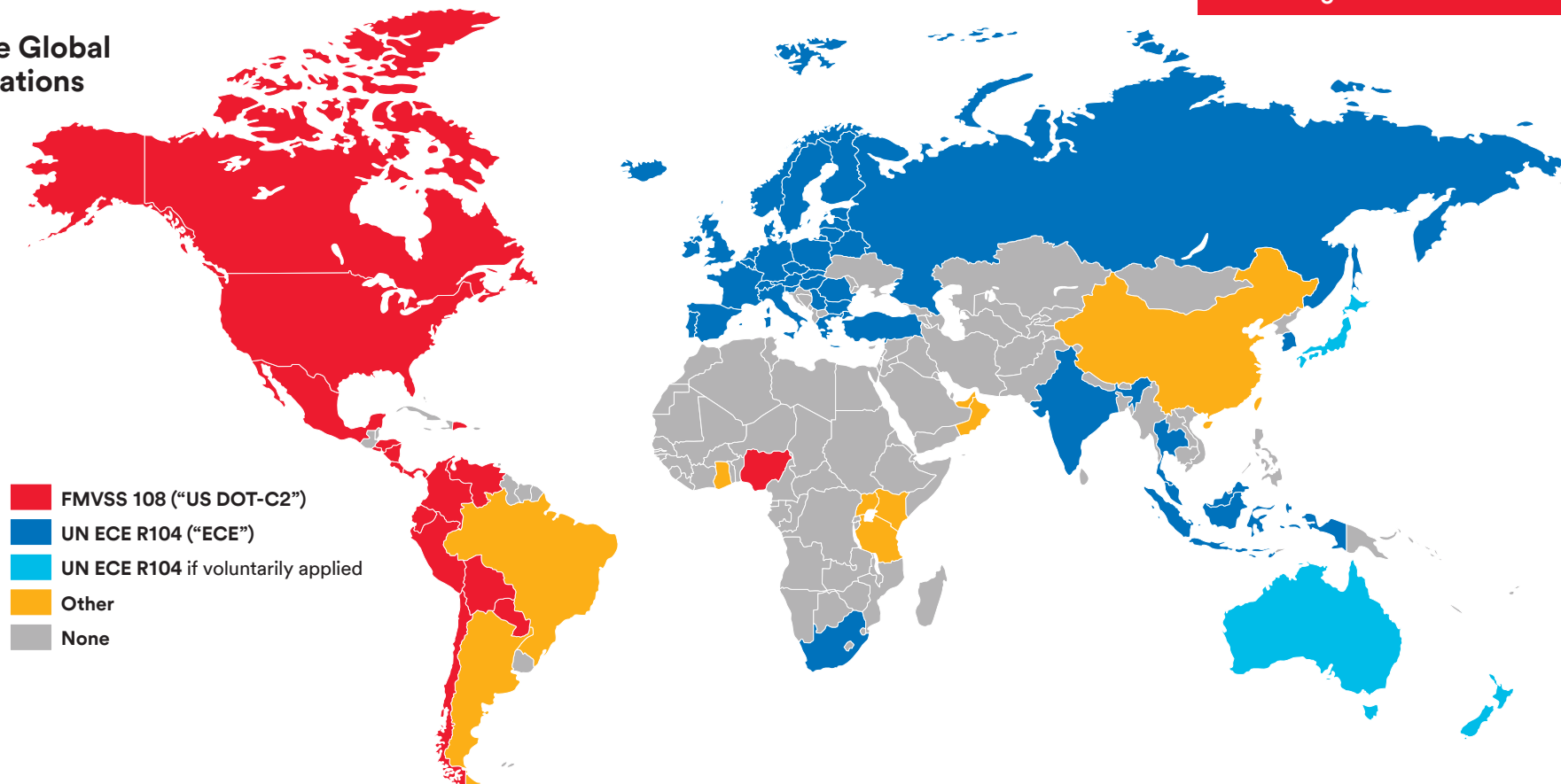
- ▶ Goods vehicles over 7,500 kg (16,500 lbs)
- ▶ Trailers with Gross Vehicle Weight over 3,500 kg (7,700 lbs.)
- ▶ Goods vehicles and trailers over 6 m long and over 2.1 m wide

### Required Application:

- ▶ Side markings: Cumulative 70% of vehicle length (gaps over one-half of marking element length are considered continuous) in yellow or white
- ▶ Rear markings: Contour (box) cover in red or yellow



## Active Global Regulations



### Covering the world with conspicuity.

Some regions have elected to follow the UN ECE R104 regulations on a voluntary basis rather than as a requirement, which can provide meaningful guidance for private companies interested in enhancing the safety and visibility of their fleet, but also means slower adoption is likely. On top of that, many other areas still have yet to adopt any form of formal regulations (voluntary or required) at all. While several of these jurisdictions are conducting tests or studies to see what if any benefits of conspicuity markings might be realized for their roadways specifically, there is a strong argument that virtually any region could realize accident reductions and cost savings by implementing conspicuity regulations on large commercial vehicles.

### Benefits beyond the trucking industry.

The principle safety and cost benefits of enhanced visibility on heavy vehicles are not limited to semi-trucks in the long-haul logistics industries either. Vehicles that are in any kind of industrial service—from freight railcars to school buses, public transportation and emergency vehicles—are all prone to similar hazards of being impacted by other drivers on the road due to visibility issues.

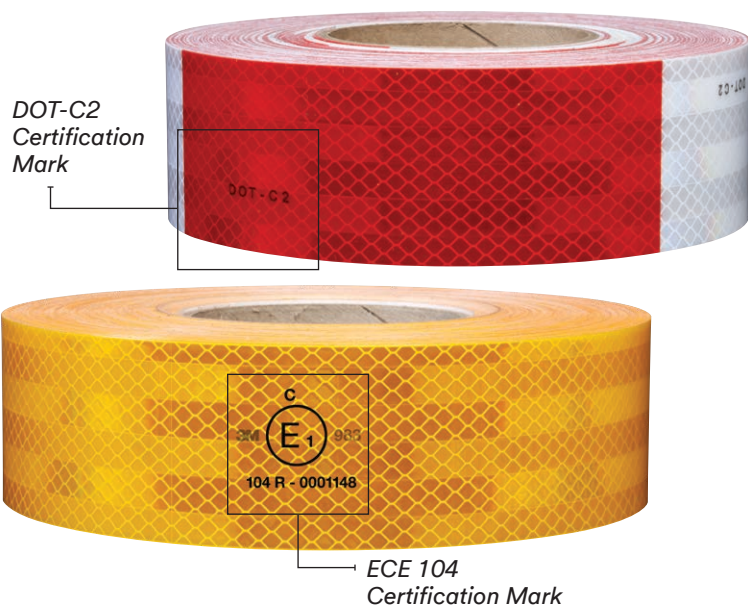
That's why regulations like the NFPA 1901 Standard for Motorized Fire Apparatus for the North American emergency vehicle segment have been adopted and updated to keep up with the latest advancements in best practices.



## Set a standard for safety.

Ultimately, whether you do business in a regulated region or not, you owe it to yourself, your drivers and everyone on the road to upgrade your vehicles with the added visibility of conspicuity markings. Being ahead of the curve on adoption not only demonstrates a higher commitment to safety—it can actually make a safety difference that helps your bottom line.

While it's possible that any amount of applied conspicuity could make a difference, using one of the major guidelines already adopted in another region is an easy way to know you're following well-established practices that have been proven to reduce crashes, injuries and the costs associated with them. To further simplify your specification process and verify your conspicuity markings not only meet or exceed all FMVSS 108 requirements, check for the DOT-C2 and ECE 104 Certification Mark embedded in the material to know you can have absolute confidence in the performance of the material.



Of course, this isn't the only characteristic that differentiates the performance of conspicuity markings. There's more to the science behind their durability and retroreflective performance than meets the eye.





# Drive with confidence.

You may not realize it, but many of the same technologies used in 3M Conspicuity Markings are already used all over the road today.

Retroreflective road safety solutions date back to the early 1930's when 3M first invented reflective tape using glass beads, and while the technology has evolved and improved drastically since then, the primary goal remains the same:

## bouncing light back to drivers

(and now, in some cases, to automated vehicle cameras) to provide critical information for staying safe on the road. That means that, whether it's a road sign telling a driver that their turn is coming up, so they should prepare appropriately, or a pavement marking helping delineate a lane for a camera on an automated vehicle, or conspicuity marking providing earlier recognition of the presence of a heavy truck, many of the same technologies are at play.

Around the world, millions of road signs are cut from the same or similar 3M materials that make up 3M Conspicuity Markings, so in a way, these markings act as “mini-signs” conveying critical information to other drivers around heavy vehicles. Likewise, this could also be invaluable to automated vehicle cameras, which rely on similar visual information to help them process and recognize the presence of other vehicles on the road.



Since it's very possible you already rely on retroreflective technologies to help guide your heavy vehicle fleets safely to their destinations, you can trust 3M Conspicuity Markings as a practical next step to make your vehicles as safe as the roads they travel on.



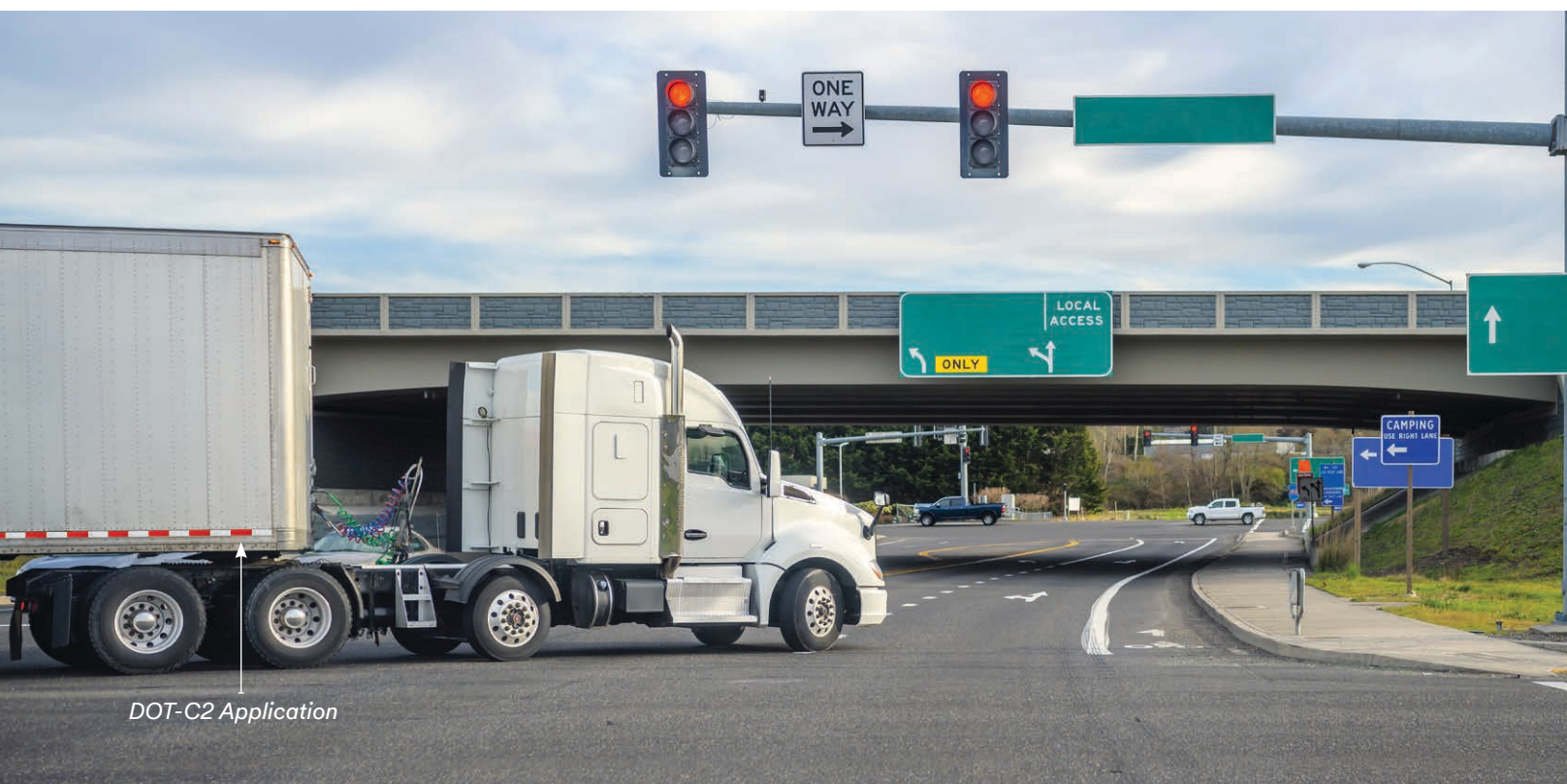
# Better performance from every angle.

Many organizations choose 3M Conspicuity Markings over other solutions because of our angular reflectivity.

High reflectivity is critical to the performance of any conspicuity solution—but that reflectivity shouldn't be limited to only performing when light sources are pointed straight-on at the marking. In many cases, the angle at which a driver approaches a heavy vehicle will depend on the area of roadway they are on. At a typical 4-way intersection where a heavy truck with a trailer is making a wide left-turn, other vehicles could be approaching it from virtually any angle.

For this reason, it's imperative that the conspicuity markings you specify for your heavy vehicles have a wide angularity—

meaning that they can reflect light back brightly even at tighter angles. Whether approaching from the rear or side, the headlight delivered by the oncoming vehicle will be more likely to be returned back to the driver sooner, giving them more time to react and potentially avoid a crash. 3M™ Diamond Grade™ Conspicuity Markings Series 983 have the widest angularity of any 3M Conspicuity Marking solution, making them our best option to help increase the safety and visibility of your trucks.





# Plan for the road ahead.

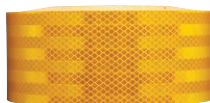
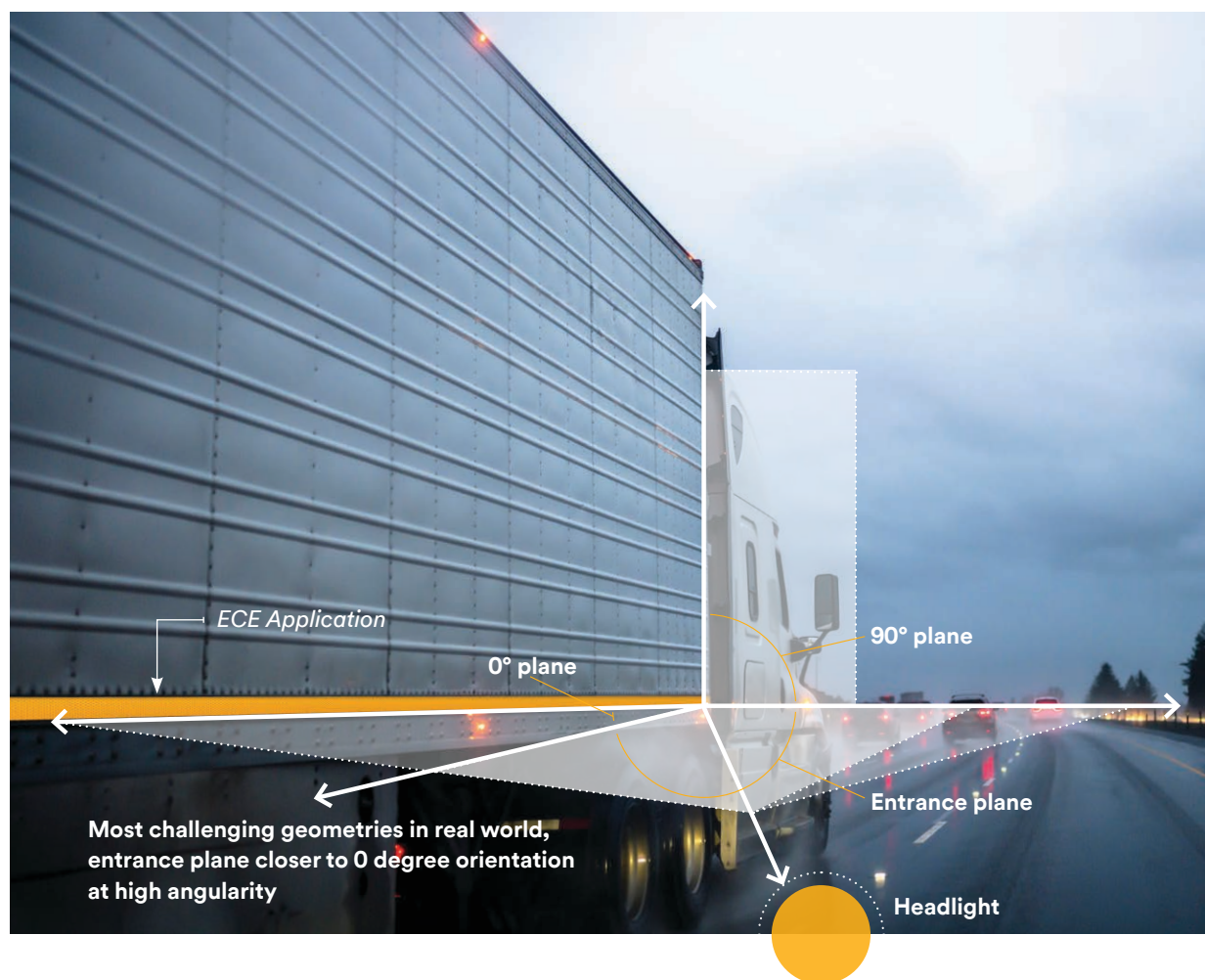
Your heavy vehicles are built to last, so be sure your conspicuity markings are too. Here's why 3M Conspicuity Markings are the best “real world” solution.

Conspicuity markings offer varied levels of performance based on the retroreflective materials from which they're made. But another factor that affects their performance over time is their durability. As the materials are weathered by environmental factors commonly found on the roads, the retroreflective elements in many markings can begin to deteriorate. It's possible that you have seen this phenomenon on a truck that has been in service for many years without replacing the conspicuity markings: the color is dull and faded, the markings may be cracked or incomplete, and the retroreflective performance is greatly diminished from when it was originally installed.

Unfortunately, this effect can be seen all too frequently, especially in countries that have had conspicuity regulations for many years and where markings have been in service for the longest period of time. From a safety perspective, the hazard this poses is doubly concerning: the vehicle may be considered compliant by the operator because conspicuity markings are present, and yet the retroreflective performance of the markings is not actually helping to increase safety in any meaningful way.

## Start seeing automated fleets.

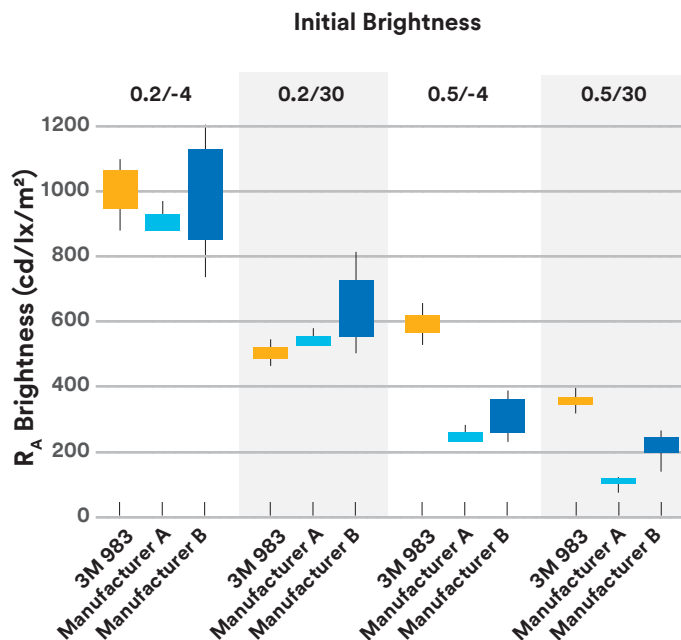
To avoid fostering this sense of false confidence in the safety of your vehicle or vehicle fleet, the best choice is to specify the most durable conspicuity solution available to you. One way you can determine the longevity of a conspicuity solution is the warranty: our most durable product, 3M™ Diamond Grade™ Conspicuity Markings Series 983, are backed by a 10-year, prorated warranty. But that's not the only reason you can trust them to perform.



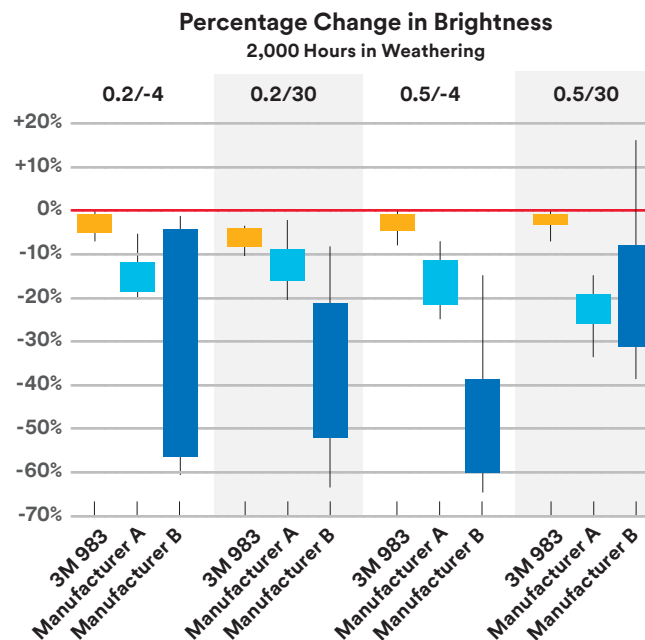
3M™ Diamond Grade™ Conspicuity Markings Series 983, are backed by a **10-year, prorated warranty.**

## DOT-C2 Performance Testing

3M™ Diamond Grade™ Conspicuity Markings Series 983 are the brightest initially.



3M™ Diamond Grade™ Conspicuity Markings Series 983 change the least during 2,000 hours of accelerated weathering.\*



Learn More.

[Download the Brochure ►](#)

\*Xe Arc Test as per  
ASTM D4956-19  
Method 1.


### The best “real world” conspicuity solution.

Series 983 Conspicuity Markings start bright and stay bright. In a head-to-head comparison against other selected manufacturers' markings, 3M showed the smallest change in brightness after 2,000 hours of accelerated weathering—a less than 10% change in its original, starting brightness.<sup>14</sup> In fact, it provides this higher brightness over a variety of angles in a typical application, superior weathering performance and the least variability in brightness due to weathering. In short, it's the best “real world” conspicuity solution because it's made to withstand the elements and keep delivering light back to drivers on the road.



14. Internal 3M testing. Data on file.





ECE Application

Plan for the road ahead

# Drive to be seen.

Whether you're a safety-minded government regulator, a large vehicle fleet owner, or simply someone who shares the road with large commercial vehicles, we can all agree that any step toward enhancing the safety of everyone on the road is a smart one. Even if they are not required by the region you operate in, putting the power of retroflective 3M Conspicuity Markings to work for you can help reduce the potential for costly crashes—and possibly save lives in the process.

**3M**

Transportation Safety Division  
3M Center, Building 225-4N-14  
St. Paul, MN 55144-1000  
1.800.553.1380

If you're interested in learning more about Conspicuity, [contact us](#), your 3M Sales Representative or visit [3M.com/Conspicuity](https://www.3M.com/Conspicuity) for more resources.

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# Sources & Suggested Reading

To learn more about the importance of reflective conspicuity markings around the world, we recommend exploring the following studies and documents referenced in this e-book.

- 1 Vector, NHTSA, US DOT FRA, UMTRI, NTSB. Emergency Vehicle Visibility and Conspicuity Study. 1983-2015.
- 2 Darmstadt University of Technology. Report. 2000.
- 3 Dutch Transport Safety Board. Accidents involving lorries maneuvering in the dark. 2003.
- 4 NHTSA. The Effectiveness of Retroreflective Tape on Heavy Trailers. 2001.
- 5 TÜV Rheinland Group. Report. 2004.
- 6 Scientific Institute of Motor Transport. Report. 2005.
- 7 Hungary Institute of Vehicle Safety Study. Investigation of the Application of Innovative Contour Markings Improving the Conspicuity of Trucks, Report on their Preventive Role during Public Road Accidents, 2009.
- 8 FEMA. FA-323 Emergency Vehicle Visibility and Conspicuity Study. 2009.
- 9 Carlson, P.J. (2001). Evaluation of Clearview Alphabet with Microprismatic Retroreflective Sheeting. Texas Transportation Institute. Texas A&M University: College Station, TX. Report # 4049-1. October 2001.
- 10 Gates, T.J., and Hawkins, H.G. (2004). Effect of higher-conspicuity warning and regulatory signs on driver behavior. Texas Transportation Institute. Texas A&M University: College Station, TX. Report # 0-4271-S.
- 11 Amjadi, R. (2008). Techbrief: Safety evaluation of increasing retroreflectivity of stop signs. Federal Highway Administration: Washington, DC. Report # FHWA-HRT-08-047. March 2008.
- 12 FMCSA. Unit Costs of Medium and Heavy Truck Crashes. March 2007.
- 13 Stichting Wetenschappelijk Onderzoek Verkeersveiligheid SMOV-rapport R-2015-2. Impact Retrofit ECE104 for NL and EU. 2015.
- 14 Internal 3M testing. Data on file.