

# Improve Road Safety with Wet Reflective Pavement Markings

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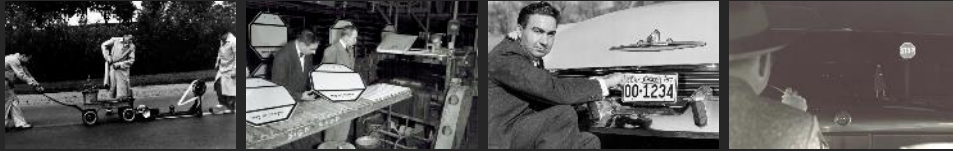
Field Based: Iowa, Kansas & Missouri | Residing in Topeka, KS

Transportation Safety Division



# 3M Transportation Safety Division History

1930

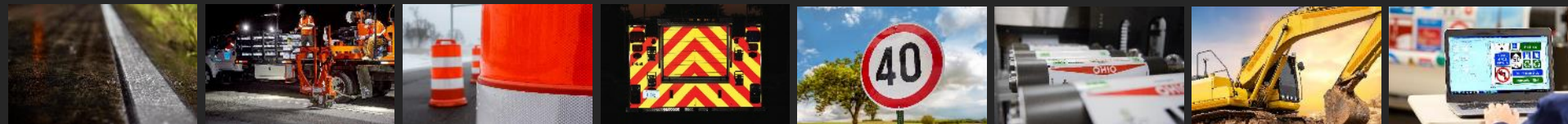


3M invents reflective sheeting and installs the first fully-reflective traffic sign in 1939; reflective technology expands to road markings and license plates.



Microreplication technology improves retro reflectivity and increases day and nighttime sign visibility. Fluorescent technology makes work zone signs and devices and pedestrian crossings more visible during dusk, dawn, and inclement weather.

2020



Wet reflective technology makes road markings visible in the rain; conspicuity markings make trucks and vehicles more visible; digital printing innovations enable enhanced graphics and more efficient traffic sign and license plate production.

# 3M Technology improves the visibility of roadway infrastructure



Signing

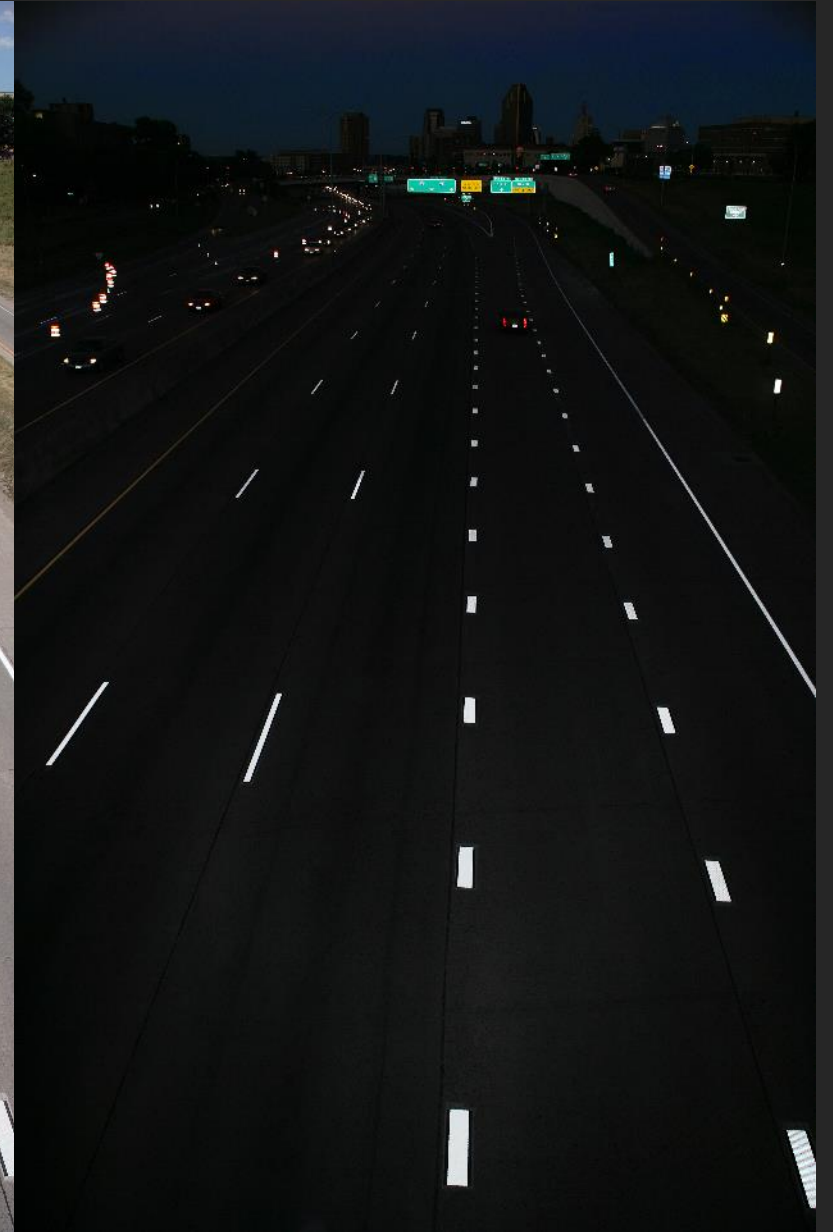


Pavement Markings



Temporary Traffic Control

Pavement markings must be visible both day and night



Driving at night in the rain  
is a big problem



In 2017, 6,952 people died in crashes on U.S. roads when it was raining<sup>1</sup>.

55% (or 3,811) of those deaths occurred at night or in low light conditions<sup>1</sup>.



Only 25% of travel occurs at night<sup>2</sup>.





# Why Wet Reflective Pavement Markings Matter

# What do drivers see?



Daytime Dry



Night-time Dry



Night-time Rainy

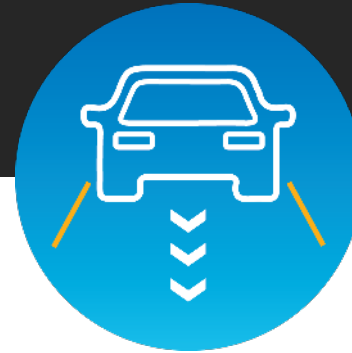
# What happens when pavement markings disappear?



Reduced  
Visibility<sup>3</sup>



Increased  
Discomfort<sup>3</sup>



Less Effective  
Lane Guidance<sup>4</sup>



Increased  
Crash Risk<sup>35</sup>

# Research links wet reflective markings to helping reduce crashes

*Safety Evaluation of Wet Reflective Pavement Markings: FHWA-HRT-15-083*

46%

Reduction in  
Run-off-road crashes on  
multi-lane roads

41%

Reduction in  
crashes with injury on  
multi-lane roads

12%

Reduction in  
crashes with injury on  
freeways



# Research links wet reflective markings to helping reduce crashes

*Safety Effects of Wet-Weather Pavement Markings: TRB 19-04199*

32%

Reduction in  
Wet – Night Crashes

49%

Reduction in  
Wet – Night Fatalities



Not all pavement marking  
optics are created equal

# Pavement Marking Optics - Video





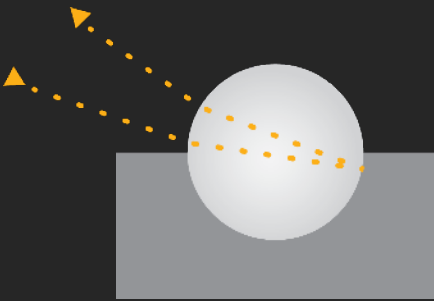
Optics in the  
pavement markings  
return light back  
toward its source.



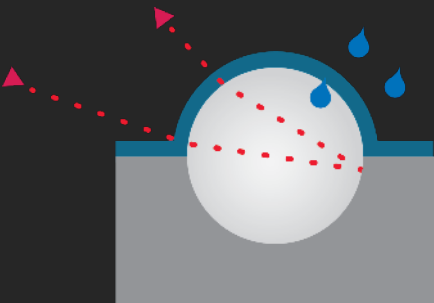
When light travels from air into water, the direction changes. This change is called refraction.



1.5 refractive index glass beads are commonly used for dry conditions,  
but fail in wet/rainy conditions

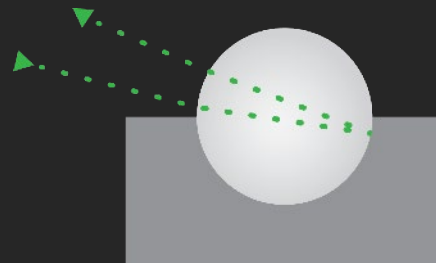


Dry 1.5 Refraction Index

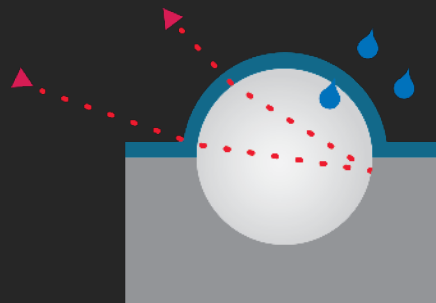


Wet 1.5 Refraction Index

# 1.9 refractive index beads are more efficient and increase light return in dry conditions, but still fail in wet/rainy conditions

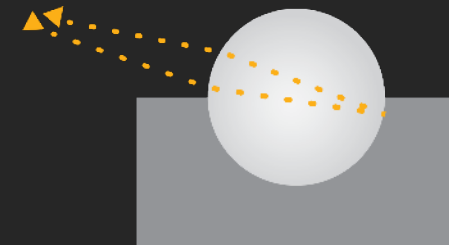


Dry 1.9 Refraction Index

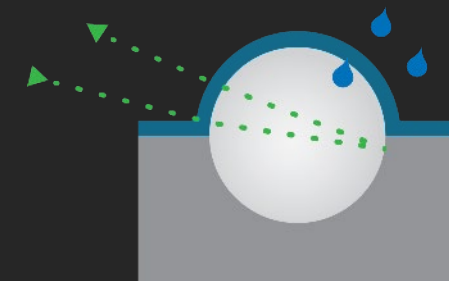


Wet 1.9 Refraction Index

# For beads, only 2.4 optics provide useful light return in nighttime rainy conditions

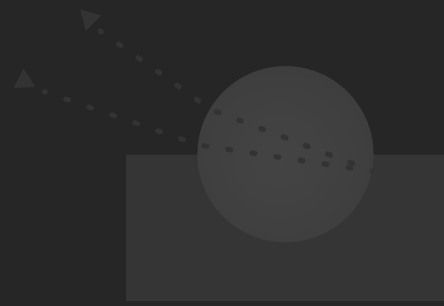


Dry 2.4 Refraction Index

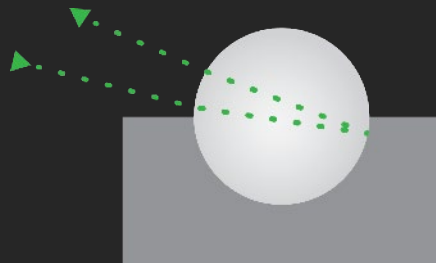


Wet 2.4 Refraction Index

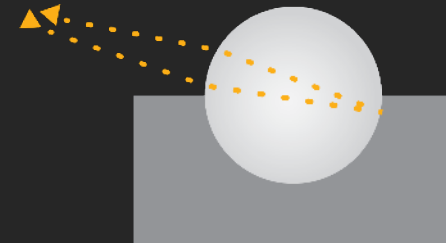
For all weather performance you want both  
1.9 and 2.4 refractive index optics.



Dry 1.5 Refraction Index



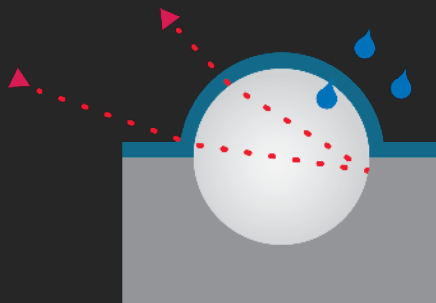
Dry 1.9 Refraction Index



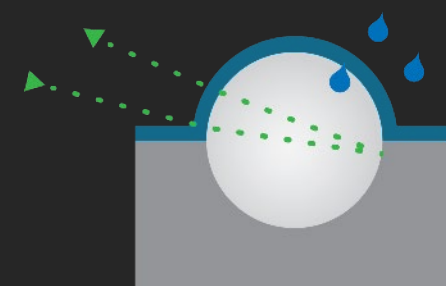
Dry 2.4 Refraction Index



Wet 1.5 Refraction Index



Wet 1.9 Refraction Index



Wet 2.4 Refraction Index

What to consider  
when building a wet reflective  
specification

# Select the Right Test Method for Wet Retroreflectivity

## ASTM Wet Continuous vs. Wet Recovery – during rainfall and after rainfall

### Wet-Continuous ASTM E2832-12

- Condition of continuous wetting
- Simulates wet reflectivity of marking during rainfall
- 5-10 mins to complete

### Wet Recovery ASTM E2177-19

- Condition of standard wetness
- Simulates wet reflectivity of marking after it's stopped raining
- 3-5 mins to complete



Wet-Continuous  
ASTM E2832-12



Wet-Recovery  
ASTM E2177-19

# Forthcoming Human Factors Research from TTI & MnDOT

Final report expected to be published this month

**Background:** Currently no minimum wet visibility retroreflectivity standards

**Project:** Determine driver needs, recommended wet continuous retroreflectivity values

**How it will be used:** Justify state-wide standards for wet reflective pavement markings



**DEPARTMENT OF  
TRANSPORTATION**





# GDOT Case Study Video



# Wet Reflective Pavement Markings from 3M

All weather solutions for many applications



3M™ Connected Roads  
All Weather Elements



3M™ Stamark™ High Performance Tape  
Series 380AW



3M™ Stamark™ Wet Reflective Removable Tape  
Series 380AW

# Key Takeaways

To learn more visit: [www.3M.com/wetreflective](http://www.3M.com/wetreflective)

- Rain and light conditions are aggravating factors in crash risk
- At night, during rainy conditions, non-wet reflective markings can't be seen
- Recent research links wet reflective pavement markings to helping reduce crashes
- Not all pavement marking optics have the same performance capabilities
- 2.4 refractive index optics provide optimal light return during rainy conditions at night
- Wet continuous test method is preferred
- Forthcoming human factors research from TTI/MnDOT to set visibility standards

Questions?

Thank you!