

# IRF - Wet Reflectivity in Road Markings - Asia Pacific Region.

Transportation Safety Division  
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16 Nov 2017

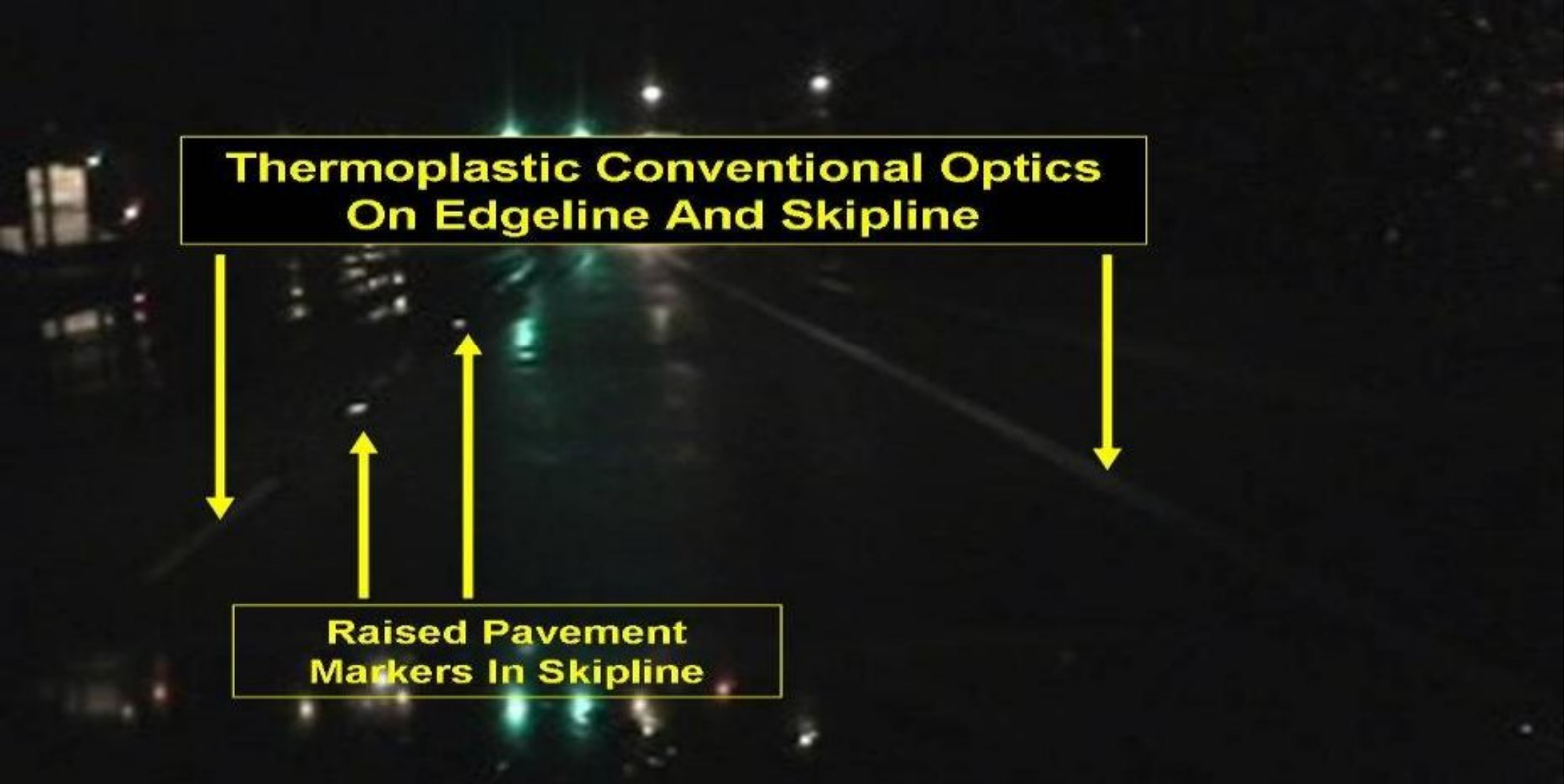
# Outline

- **Science of Wet Reflective Line Marking**
- **Research on Road Line Reflectivity and Traffic Safety**
- **Application of High Refractive Index in Pavement Markings**
- **Apac Regional Wet Reflective Initiatives**

# Scenario during Wet Night 1

**Thermoplastic Conventional Optics  
On Edgeline And Skipline**

**Raised Pavement  
Markers In Skipline**



## Scenario during Wet Night 2

### Side by Side

Conventional lane markings

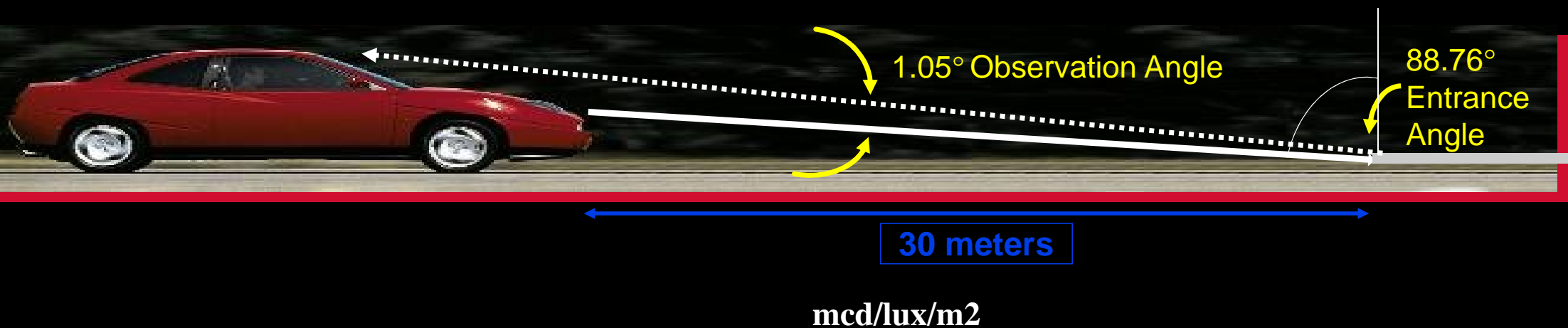


Wet reflective markings

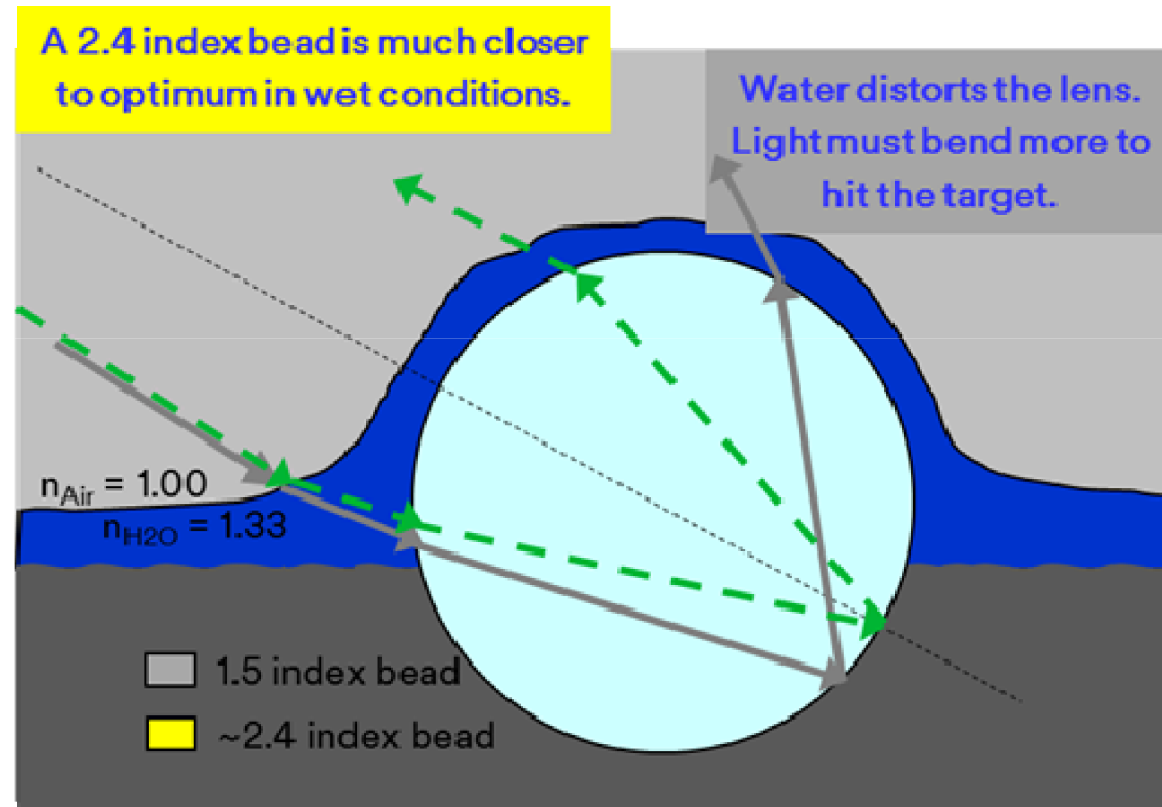
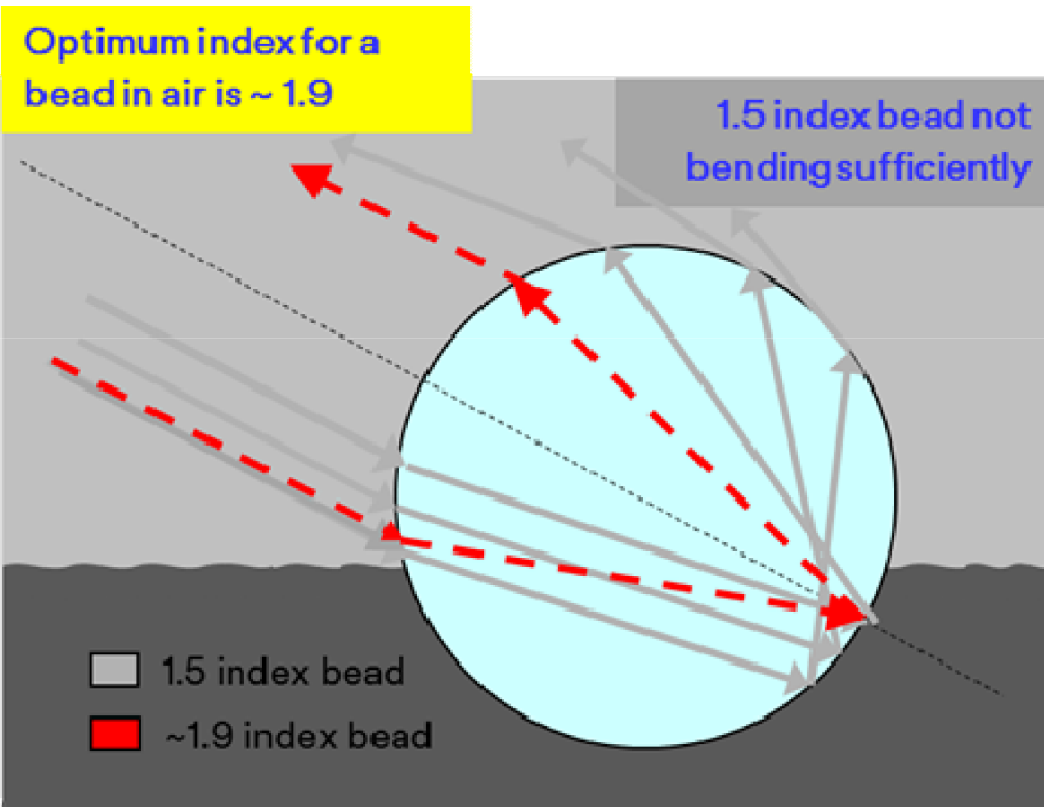


# Pavement Marking Visibility Challenges

- Pavement markings are viewed at extreme horizontal angles, very different from what is seen with sign sheetings.
- Modern instruments reliably measure reflectivity approximate to what is seen at 30 meters, This 30 meter measurement is often referred to as “driver geometry” Many older instruments measure at angles which do not directly relate to what can be seen on the road.
- Due to the extreme angles and practical optical systems, retroreflectivity numbers are extremely low and measured in milicandelas ) 1/1000 of the units used in sign sheeting.

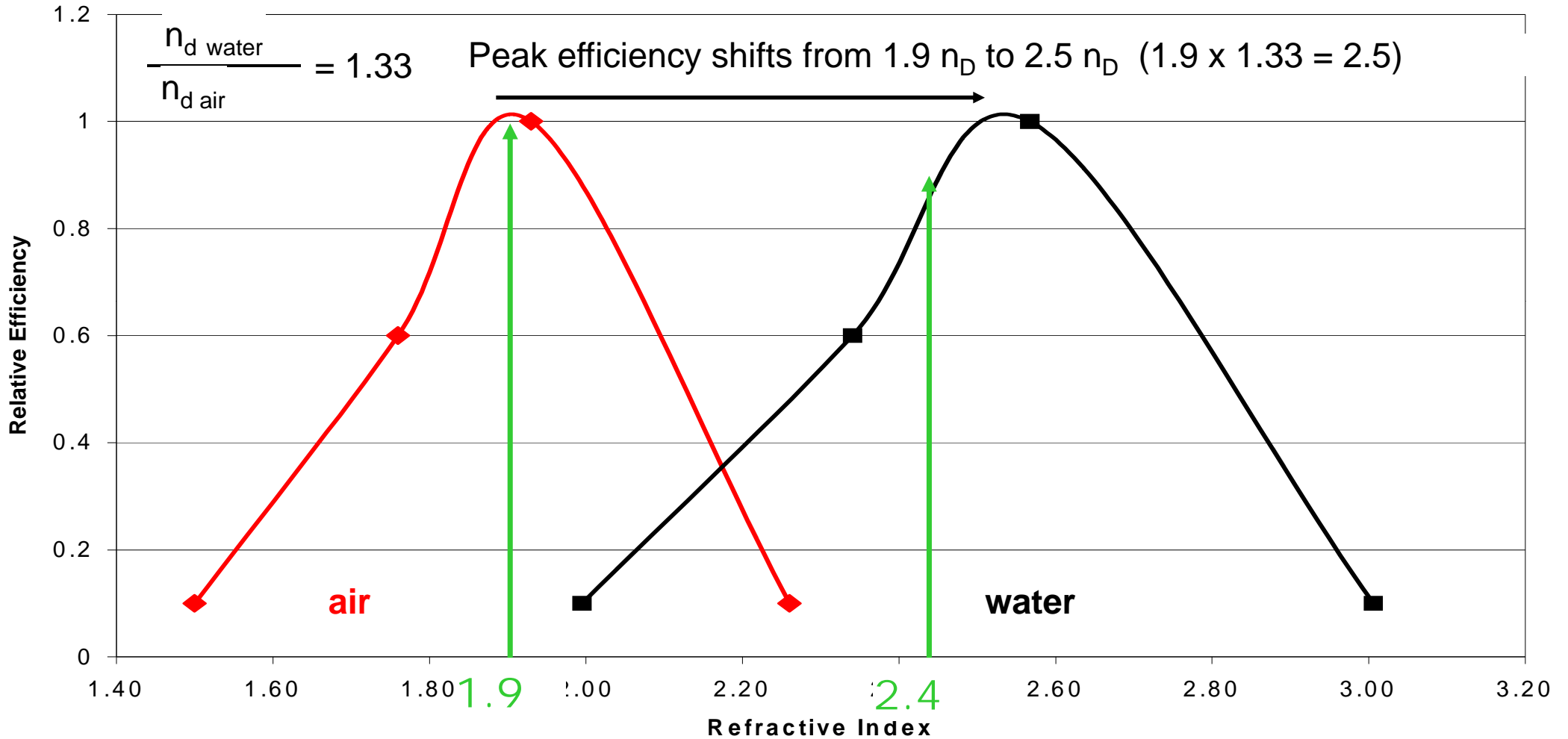


# Interactions of Vehicle Headlights and Pavement Marking Materials: Solutions for Visibility at All Weather



**3M All Weather Optics have dry reflective beads at peak efficiency, and wet reflective beads much higher in efficiency than any other commercial beads.**

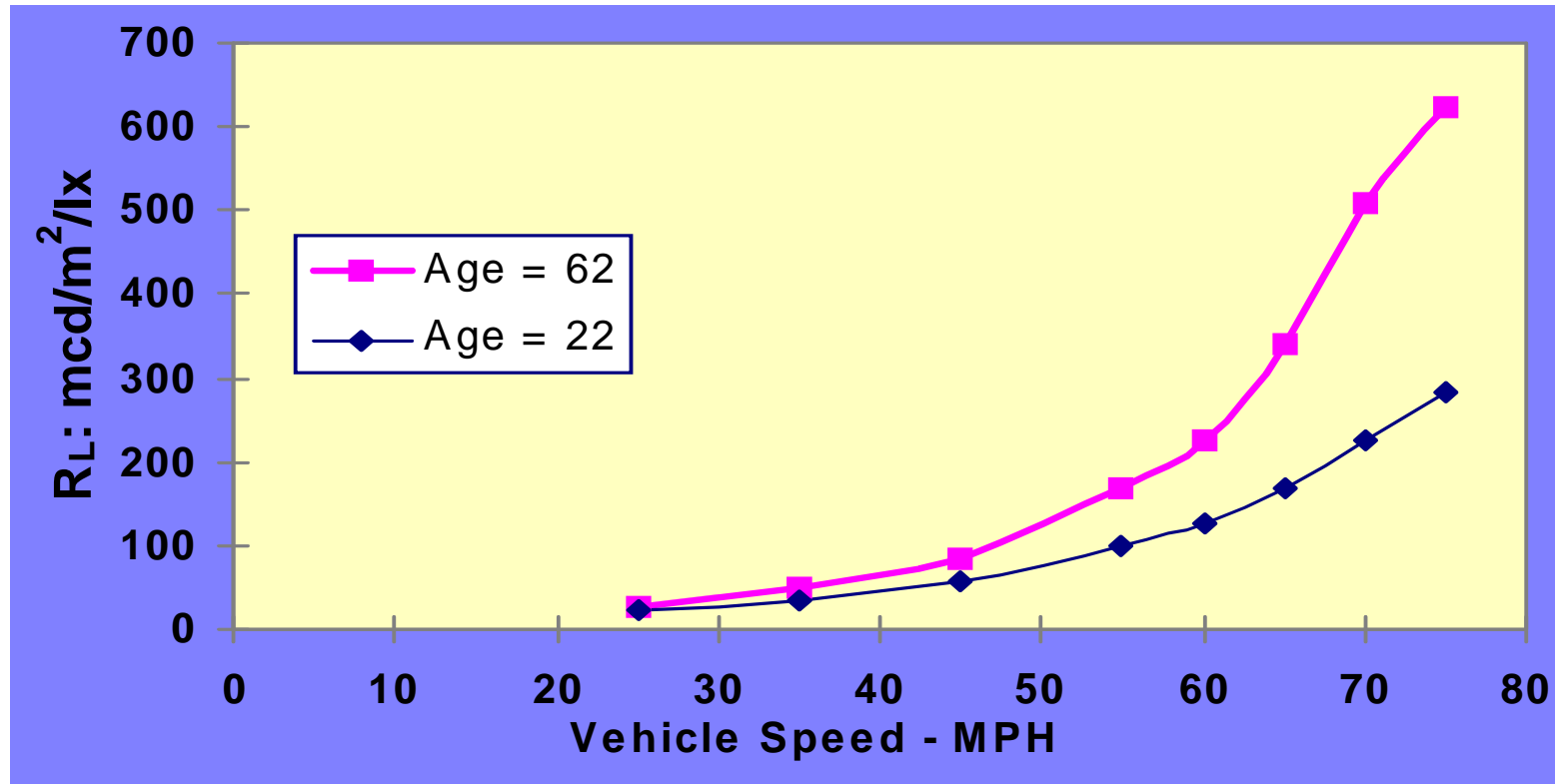
Theoretical Efficiency Versus RI



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# Minimum Required Brightness for Drivers of Different Ages



GE H6054 Low beam; Fully marked road. Preview time of 3.65 sec.

From Prof. Zwahlen, Ohio University.

# Pavement Marking Reflectivity has Impact on Safety

- 11-24% crash reduction when striping retroreflectivity is increased by 200-300mcd
- Texas Transportation Institute (TTI) study used North Carolina pavement marking data

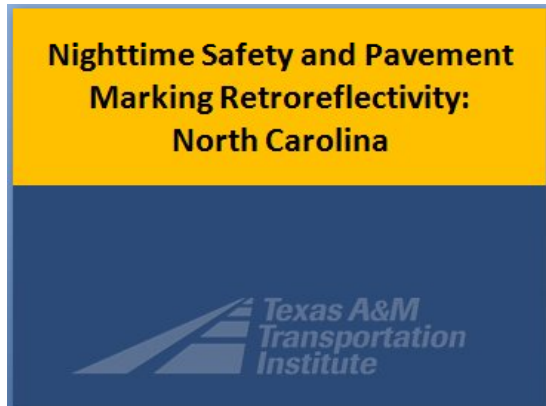


Table 9 Implications of Results for Various Restriping Scenarios

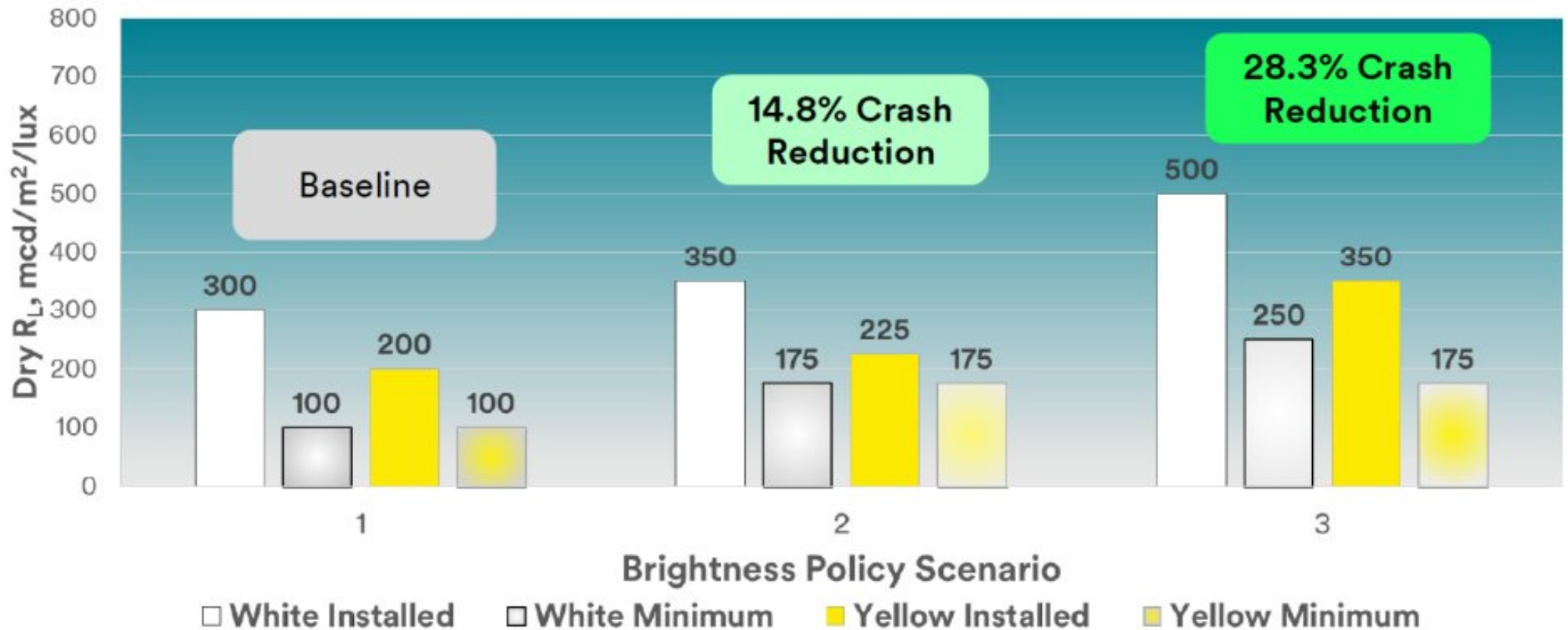
	Minimum In-Service $R_L$ (mcd/m <sup>2</sup> /lx)		Minimum Installed $R_L$ (mcd/m <sup>2</sup> /lx)		Delta W <sup>b</sup>	Delta Y <sup>b</sup>	Average Yearly Crash Reduction
	W Edge	Y Cntr	W Edge	Y Cntr			
Scenario 1 <sup>a</sup>	100	100	300	200	200	100	11.9%
Scenario 2	100	100	400	200	300	100	22.4%
Scenario 3	150	150	300	200	200	100	12.3%
Scenario 4	150	150	400	200	300	100	23.8%

Notes:  
a The Minimum In-Service  $R_L$  for this scenario was used as a reference to calculate the estimated Average Yearly Crash Reductions for all scenarios in this table.  
b These deltas are computed with respect to Minimum In-Service  $R_L$  from Scenario 1.

Source: 2014 TTI report: “Nighttime Safety and Pavement Marking Retroreflectivity on Two-Lane Highways: Revisited with North Carolina Data”

# Brighter pavement markings helps save lives

Nighttime Safety and Pavement Marking Retro reflectivity on Two-Lane Highways: Revisited with North Carolina Data  
Paul J. Carlson, Raul E. Avelar, Eun Sug Park, Dong Hun Kang. Texas A&M Transportation Institute.



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# Double-drop AWT Application Equipment



# Double-drop AWT Application in Operation

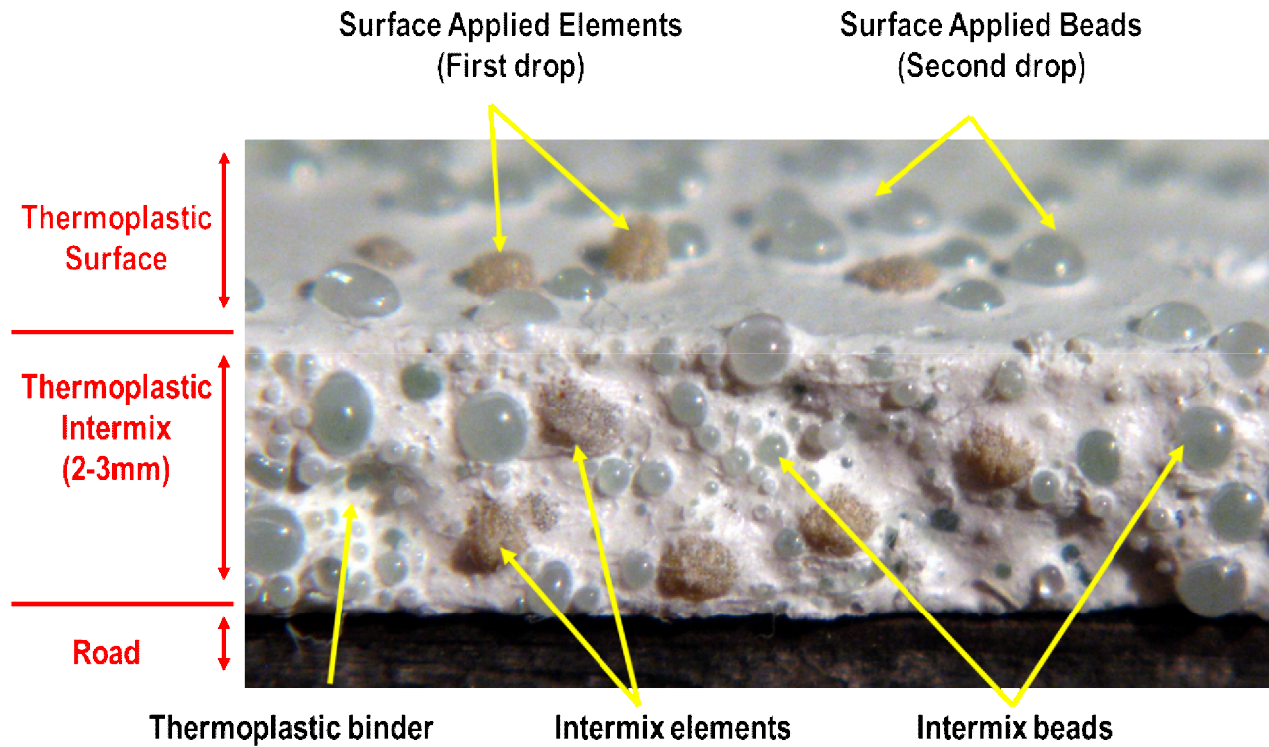


# 3M AWT Pavement Marking Lines

AWT Top View



AWT Cross Section



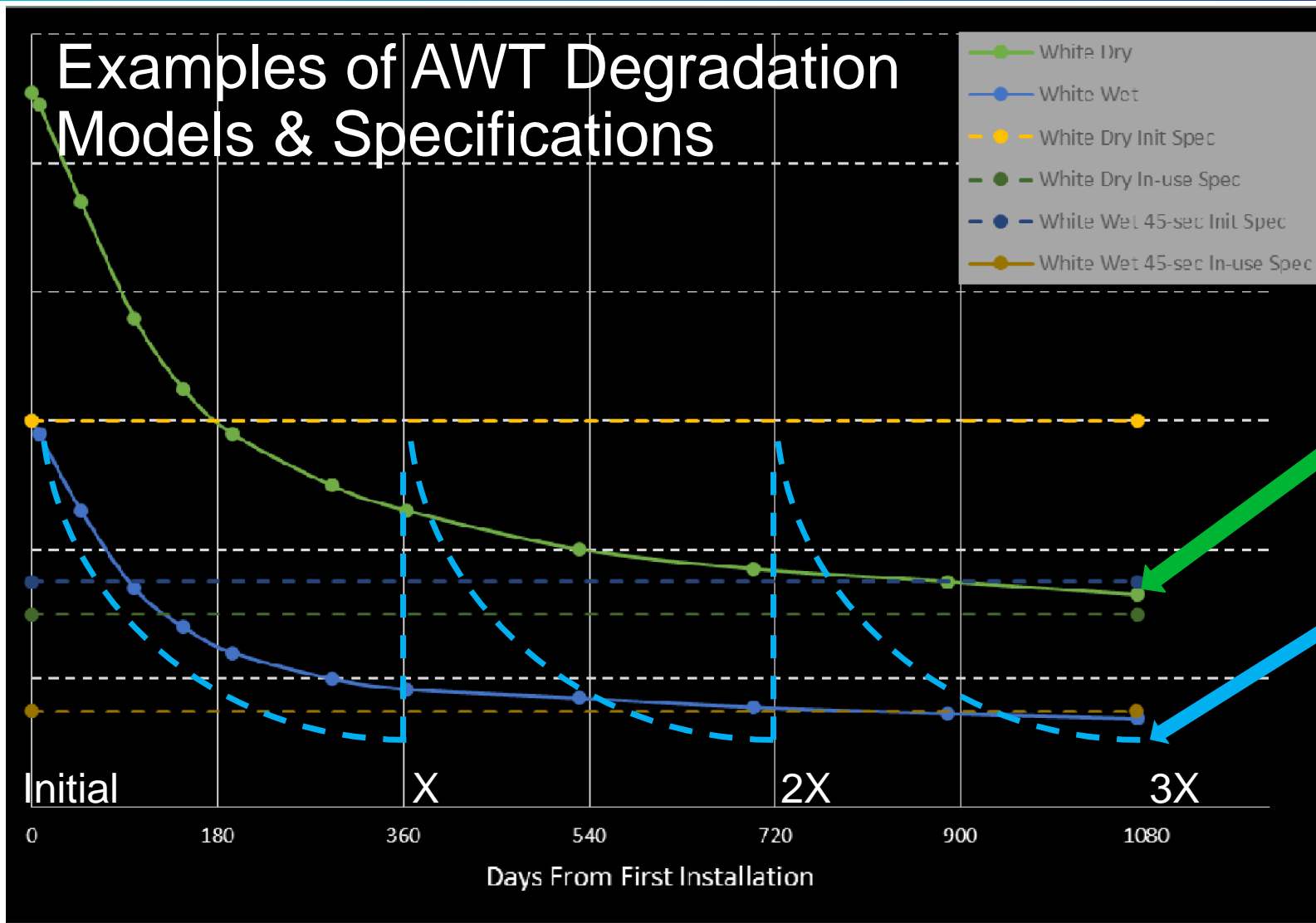
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# Regional Wet Reflective Specifications

Country		Time / Period	DRY		Wet Rec (45s)		Wet Cont.	
			ASTM E1710		ASTM E2177		ASTM E2832	
			White	Yellow	White	Yellow	White	Yellow
1	<b>Philippines DO 103 Nov 2013</b>	7 days	325	200			100	50
		6 months	200	100			75	N/A
		1 year	150	75			50	N/A
2	<b>India IRC 35:2015</b>	Initial	350				100	
		2 years	150				50	
3	<b>Singapore SS 589:2013</b>	7 days	300	160	150			
		5 months	150	50	80			
4	<b>Malaysia JKR/SPJ/2012-S6</b>	7 days	300	200			75	75
		12 months	150	N/A			N/A	N/A
5	<b>Korea MLTM &amp; KS2521</b>	Initial	250	175			175	125
	<b>Korea NPA</b>	6 months	120	N/A			N/A	N/A

# Examples of AWT Degradation Models & Specifications



All Weather Thermoplastic Degradation (dry performance)

Normal Thermoplastic Degradation (dry performance)

# Conclusions

1. **Wet Reflective** Pavement Marking Lines are visible at night and during rain.
  - Enabled by **3M optical elements** of 2.4 refractive index
  - Important for drivers and autonomous vehicle sensors to keep to the lanes
2. Attendant attributes of 3M wet reflective elements
  - Coupled with **superior dry weather** Retroreflectivity
  - **Superior durability** of PM lines for retained wet and dry performance
3. Brighter lines were shown to have an impact of **reducing traffic crashes** by up to 28%
4. Apac regional countries have in place wet reflective PM specs.
  - **Malaysia, Singapore** and **Korea** have enforcement too.
  - Specifications are in the range of 300 mcd/lx/m<sup>2</sup> initial dry and 75-150 mcd initial wet.
  - **India** and **Philippines** have enacted wet reflective PM specs as well, but yet to enforce.
  - All five countries have retained specification of retro-reflectivity.
  - Other countries are assessing solutions with aim to set the specifications.