



CANADA'S RAILWAYS

Railway Equipment ReflectORIZATION

Training on the requirements of Reflectivity Inspections

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Background

- Original rule required renewal of the reflective material on cars and locomotives within 10 years of it's original application.
 - true lifespan was not known at the time
 - history has now shown this is not always necessary to maintain safety
 - field surveys of several hundred pieces of equipment resulted in only a small number of reflectors requiring renewal
- An exemption to the requirement to renew the material within 10 years was approved by Transport Canada
 - based on extensive studies which have been conducted and subject to the requirements identified within this presentation
 - this aligns with the direction being taken in the US
- Revised Canadian *Railway Equipment Reflectorization Rules* will be consistent with these requirements.

Photo and Technical Credits

- Photos contained within this presentation as well as technical information within Addendum C are provided by the American Association of Railroads (AAR).

Who does this affect?

Employees responsible for performing:

- an annual locomotive inspection; or
- a single car air brake test.

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What is my responsibility in relation to reflectivity?

The impact of cleaning is dramatic under a light source

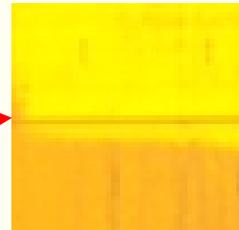
Ensuring that the reflectivity maintains the level of safety for which it was intended.

1. Reflective sheet must be cleaned.
2. Examine each individual sheet on the car/locomotive from a uniform distance (15ft preferred) with a light source.

Upper portion
cleaned
without a light
source



Cleaned and
shown with a
light source

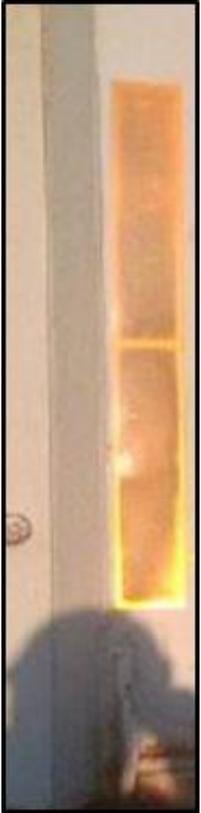


What am I looking for on inspection?

Damage which affects the reflective abilities of the sheet.

- From visual inspection using a light source, ensure:
 - there is no internal failure;
 - it is not in condemnable degradation (i.e dark, non-reflecting portions), or
 - it is not completely obscured.

Internal Failure Examples

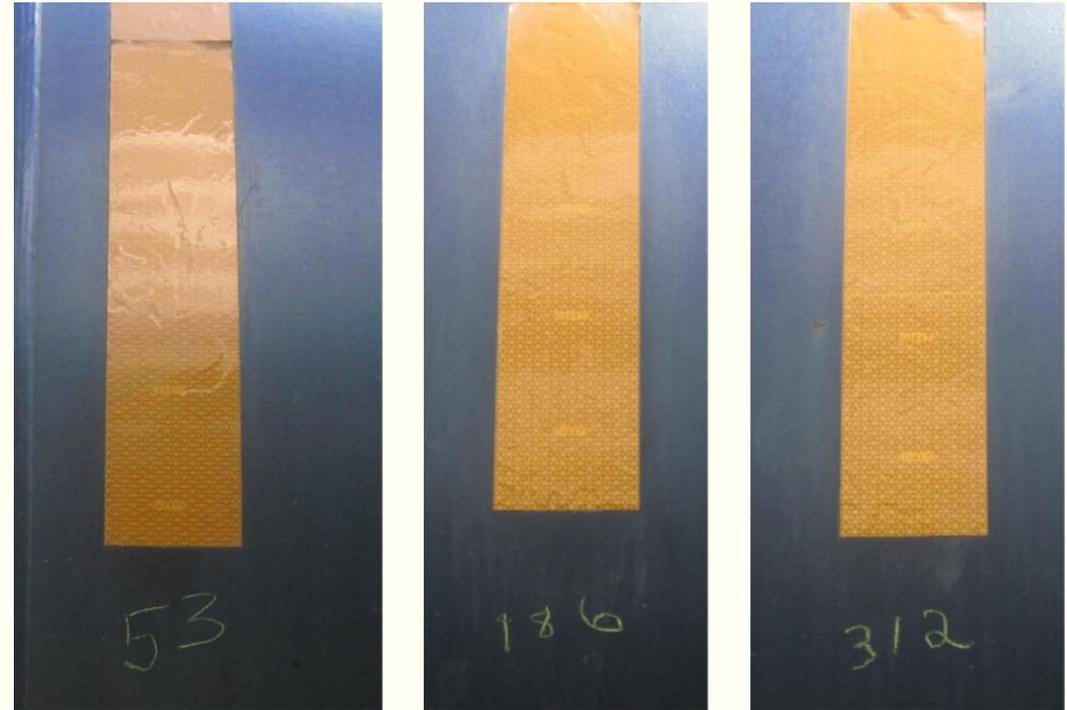


- Reflector performance typically degrades over time, this example was an early failure.
- This degradation is not always evident in reflector appearance.



Material Degradation

- These 3 strips were side by side on the same tank car.
- Number value is measured reflectance in “cleaned” condition.



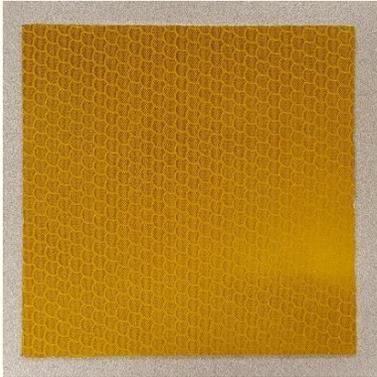
What if the reflective sheet does not pass initial inspection?

It must be:

- renewed; or
- tested utilizing the Performance Inspection procedure.

Comparator Panel

The Performance Inspection requires use of a Comparator Panel within the calibration date



Comparator Panel

Measures 4" x 4" with calibrated reflectivity

Back of Panel

If not on the front, will contain information in relation to manufactured date and reflectivity value.

A panel is considered within calibration for one year from either the manufacturing or calibration date.

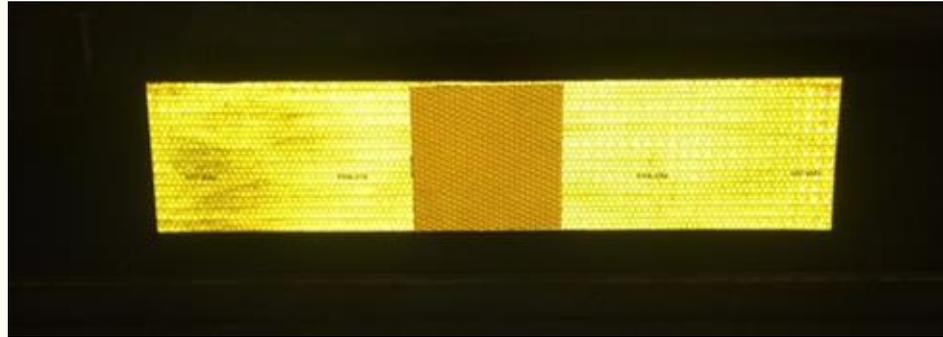
Performance Inspection Procedure

1. Verify Comparator Panel is within one year of the calibration date.
2. Select a distance which can be maintained for inspection of all reflective sheets on the car/locomotive.
3. For each reflective sheet:
 - a) place the panel over the center of the reflective sheet
 - b) hold the light source adjacent to your eye straight out from the side of the car/locomotive
 - c) compare the reflected light intensity of the reflector to that of the panel.

Performance Inspection Pass

Comparator Panel is dimmer

In the following example, the reflective sheet on the car/locomotive is brighter than the Comparator Panel



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Performance Inspection Fail

Comparator Panel is brighter

In this example, the reflective sheet on the car/locomotive is not as bright as the Comparator Panel



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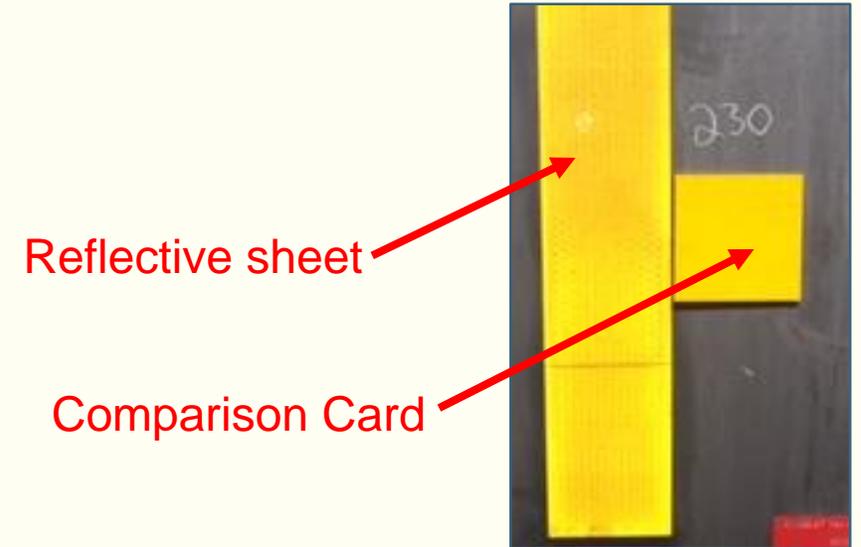
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Performance Inspection – Close Call

When not certain, it must be considered failed

If it cannot be determined whether the reflective sheet or Comparator Panel is brighter, it is considered as not passing Performance Inspection and must be handled accordingly.



Requirements on Performance Inspection failures

If, on more than 20% (4"x18") of a reflective panel:

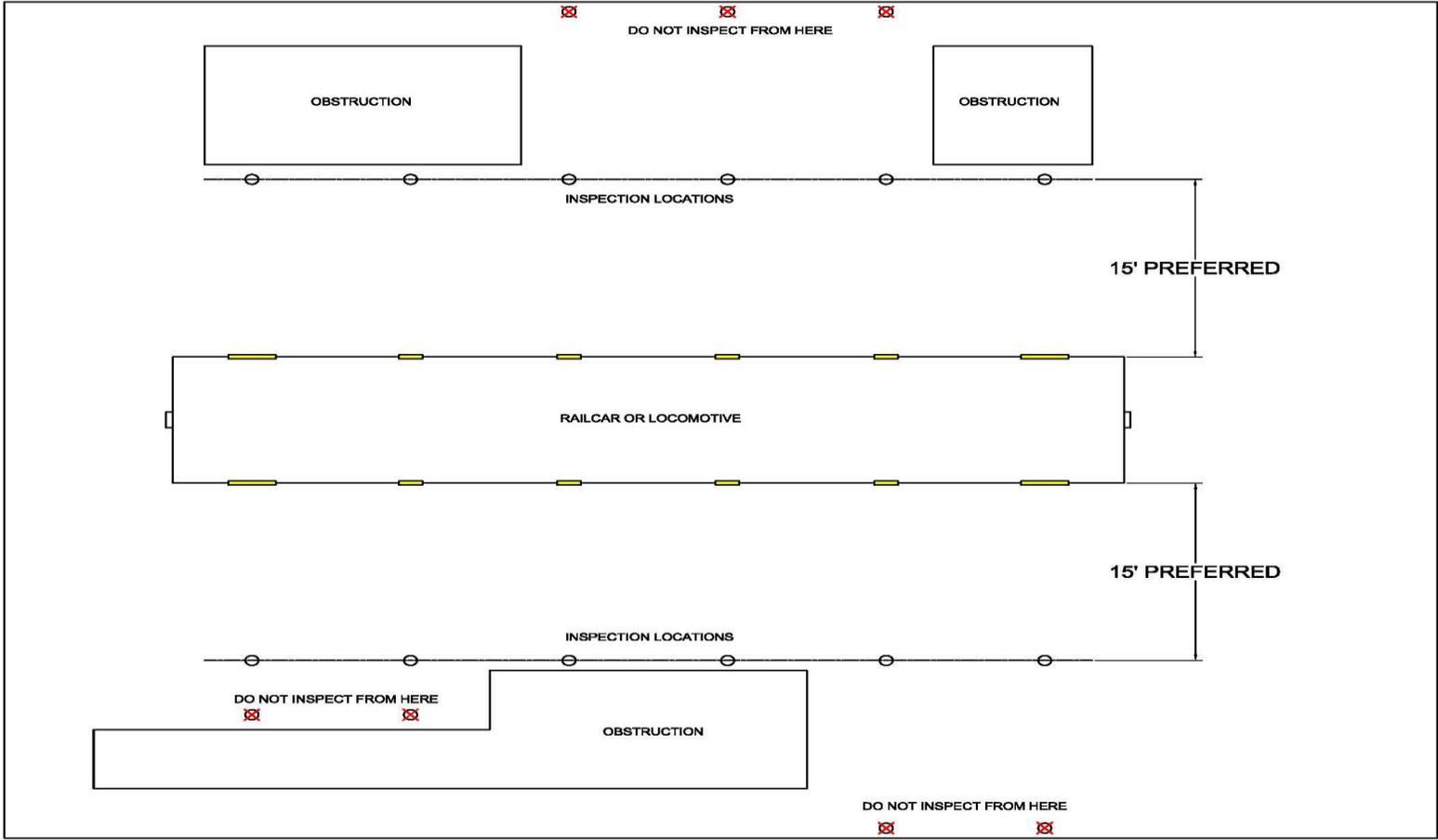
- the reflected light intensity difference between the reflective sheet and Comparator Panel cannot be discerned, or
- the Comparator Panel is more reflective than the reflective sheet

the reflective sheet(s) which did not pass inspection must be replaced and bill why made code 1F (Does not meet minimum reflectivity levels).

How to perform an Optimum Comparison

- The further back from the equipment you can stand, the less it will be influenced by viewing position and light source orientation.
- The darker the ambient conditions and brighter the light source, the more pronounced the comparison will be. Bright locations may require a flashlight with approximately 800 lumen intensity.
- Viewing angle should be close to perpendicular with equipment side.
- Distance and viewing angle should be held consistent from reflector to reflector on the same side of the equipment in order to reduce variation once “calibrated”.
- The closer the comparator is to the reflector the less the viewing angle will differ (hence the 4” x 4” comparator that can be placed in the middle of a reflector).

Inspection Locations



Addendums

A – Employee Q&A's

B – Company Q&A's

C – Background on AAR study

D – Example Instructions

Addendum A

Employee Questions & Answers

Q1: Does the reflectivity need to be tested monthly?

A1: Reflectivity be inspected at the time of the Single Car Brake Test for cars and for locomotives, during the annual inspection.

Q2: Must I always use the Comparator Panel for inspection?

A2: No, if the equipment passes initial inspection by an qualified inspector there is no requirement to perform the Performance Inspection.

Q3: Can reflectivity be deemed defective without use of the Comparator Panel?

A3: Yes. If found defective on initial inspection, the reflective material must be replaced or, a Performance Inspection performed using the Comparator Panel.

Q4: What is considered defective?

A4: Reflective material which has an internal failure, condemnable degradation or is completely obscured.

Q5: Following a Performance Inspection, am I required to replace **all** reflective material?

A5: No. The exemption requires that there not be 20% or more defective on each panel (Each sheet 80% good).

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Addendum B

Company Questions & Answers

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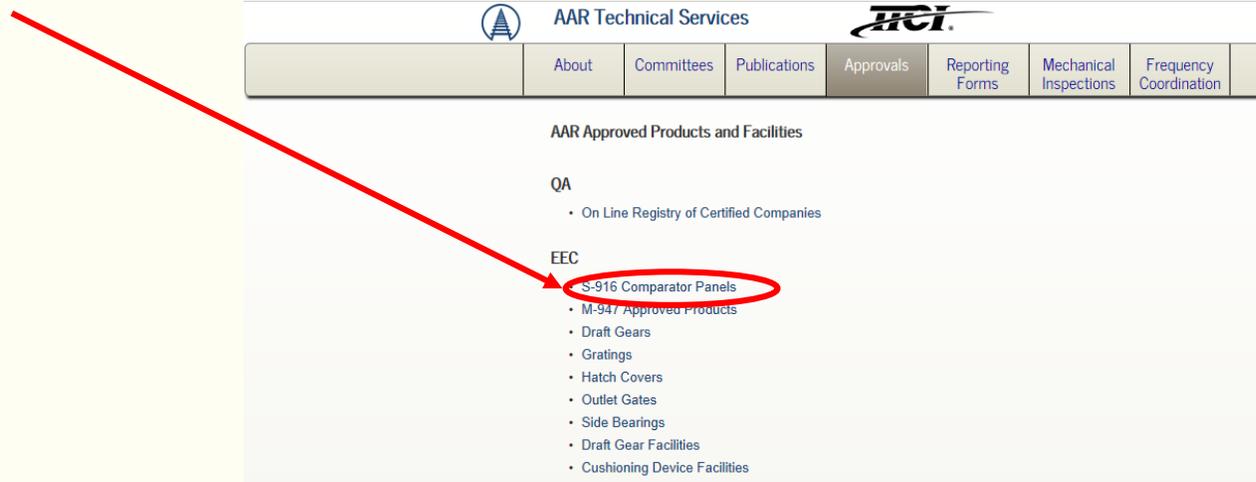
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Q1: Where are approved Comparator Panels available?

A1: Approved vendors are noted on the AAR website under standard approvals and will be added to the RAC site as well.

<http://www.aar.com/standards/approvals.html>



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Q2: How long are the Comparator Panels considered good?

A2: They must be replaced or calibrated annually.

Q3: How was annually determined?

A3: The annual calibration is a starting point based on typical AAR Quality Assurance requirements. Experts have indicated that panel calibration could hold up for ten years if the panel is not used and properly stored. In the case of a poorly treated panel it may only hold up for months. At a minimum it must be calibrated annually but more frequent calibrations may be required when the panel is not treated as well.

Q4: Where can they be calibrated?

A4: From the vendor.

Q5: Are there revised rules which will cover these requirements?

A5: Not at this time. The exemption requires that the existing rule be revised consistent with these requirements within 10 months. Until such time, the industry must comply with the requirements of the exemption.

Q6: Are there example instructions for affected employees which could be used to ensure consistency?

A6: Addendum D contains instructions which may be used.

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Q7: May a company revise the instructions contained in Addendum D?

A7: Yes as long as it does not result in an instruction which is less restrictive than the requirements of the exemption.

Q8: Can this presentation be used to implement these changes?

A8: Yes, the portion of this presentation up to the addendums have been developed to assist with roll out.

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Addendum C

Background on AAR study

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Background

- CFR 49 Part 224 (Reflectorization) currently requires that all reflectorization be replaced after 10 years.
- AAR successfully petitioned the FRA for a waiver of this 10 year renewal requirement as we were able to demonstrate that the current performance of the material indicated it would last well beyond 10 years.
- AAR further proposed that a performance based test was more economically viable and easier to manage if tied to the single car air brake test or annual locomotive inspection.
- FRA originally granted a 3 year waiver on the 10 year renewal requirement and AAR would use this time to develop a performance based method.
- Grandfathered cars are to have material replaced regardless of condition.
- Canadian Railway Equipment Reflectorization Rules have been revised consist with US Rules.

Volpe Study

Volpe determined that the minimum detectable level was 45 based on 1 square foot of material

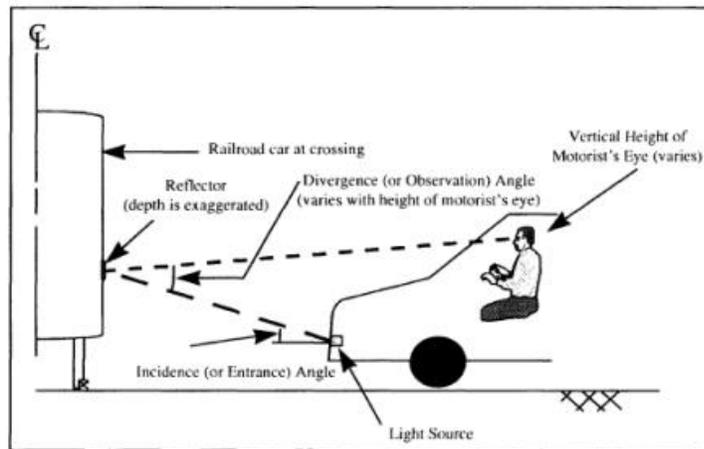
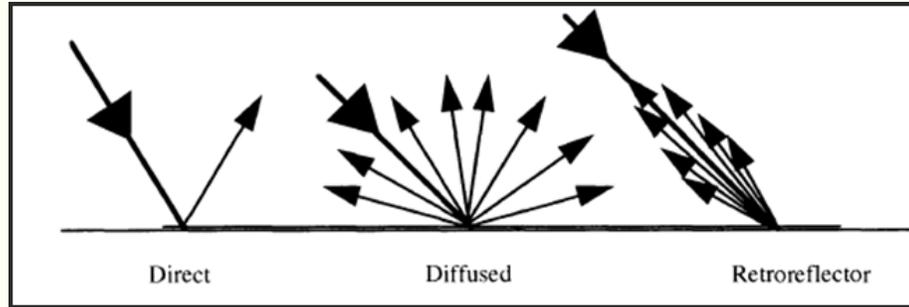


Figure 2-2. Graphical Representation of Incidence and Divergence Angles with Respect to a Railroad Freight Car (Not to Scale)

$$E_e = \frac{I_s A B t^{2d} W H}{d^4}$$

Allard's Equation:

E_e = Required Level of Illuminance 2.3×10^{-6} footcandles

d = Required Detection Distance 500 feet

W = Windshield Transmittance 0.70

H = Headlight Efficiency 0.85

I_s = Headlight Intensity 3000 cd (per headlight)

t^{2d} = Atmospheric Transmittance 0.945

B = Reflector Brightness

The results indicate that the reflector brightness must have an overall reflective intensity of approximately

45 cd/footcandles/ft²

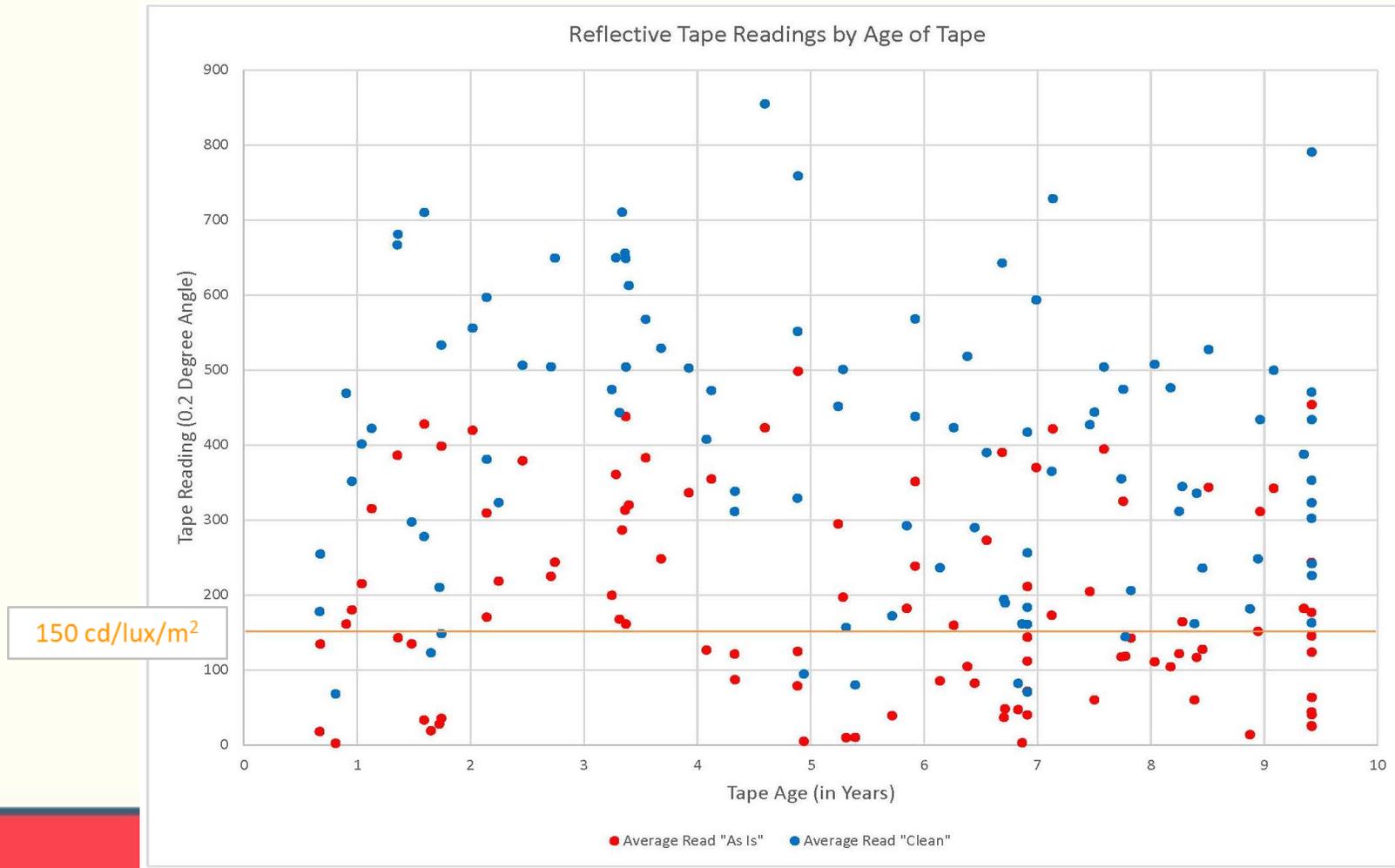
Who is Volpe?

- National Transportation Systems Center with mission to improve transportation by addressing emerging issues and advancing understanding.
- Part of the US D.O.T. that is 100% funded by sponsor projects.
- Volpe partners with public and private organization to assess transportation needs and influence decision making through comprehensive analyses.

Comparator Development

- AAR developed a system similar to that used for highway road signs (comparator method).
- The AAR comparator takes into account that crossings are not always perpendicular to the roadway.
- 80% of all crossings are between 60-90 degrees (Per Volpe).
- Required minimum (45 per Volpe)/(correlation ratio = reduction from 0.4 degree entrance angle to 30 degree entrance angle = (45%)) + Area reduction factor (Cosine 30 degrees = 15%) = AAR Minimum (115)
- AAR further proposes a minimum of 150 in order to provide a reasonable assurance of maintaining minimum performance for some period after single car air test or annual locomotive inspection.
- The comparators are to be manufactured with a value of 150 to 170 as a range can be more easily mass produced.

AAR Proposed Minimum



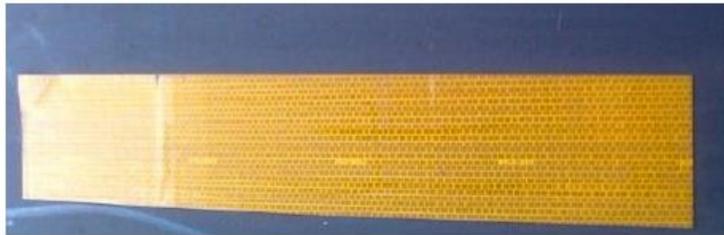
Reflectivity Product Identification

Note that all material must have "FRA 224" stamp in order to be applied and to remain in service.



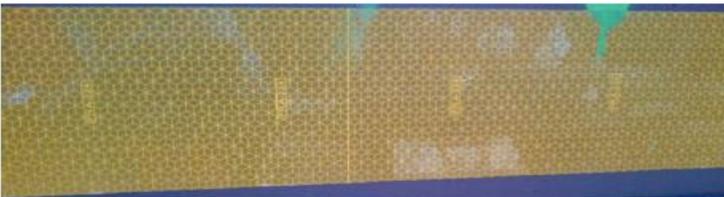
3M Product:

1. Diamond shaped pattern.
2. Wide Striped appearance when illuminated.
3. FRA-224 Stamp Lateral



Avery Dennison:

1. Rows of small squares.
2. FRA-224 Stamp Longitudinal.

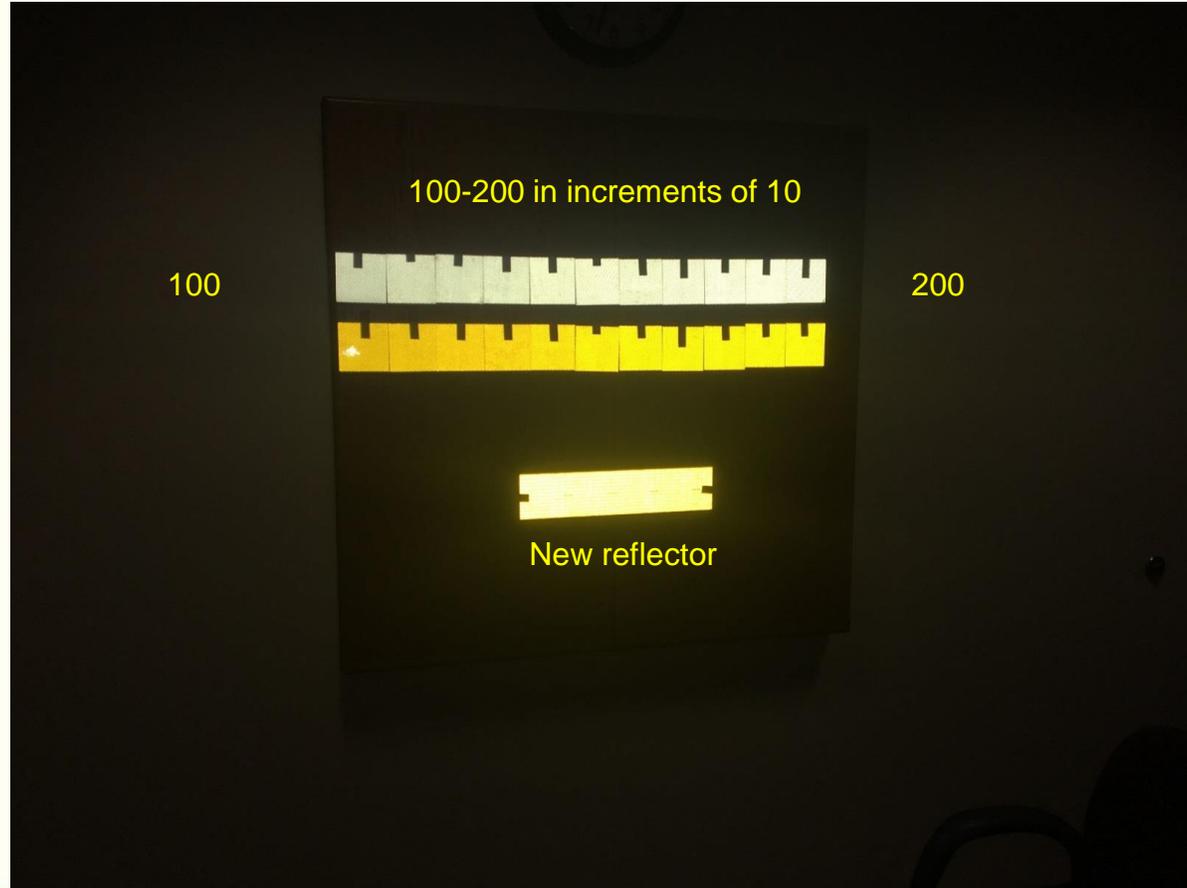


Reflexite:

1. Overlaid Hexagon pattern.
2. FRA-224 Stamp Lateral.

Multiple Reflective Values

The human eye can discern subtle differences in retroreflective values



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Multiple Reflective Values – con't

Too bright of a light source can “wash out” the reflectors and make them harder to compare



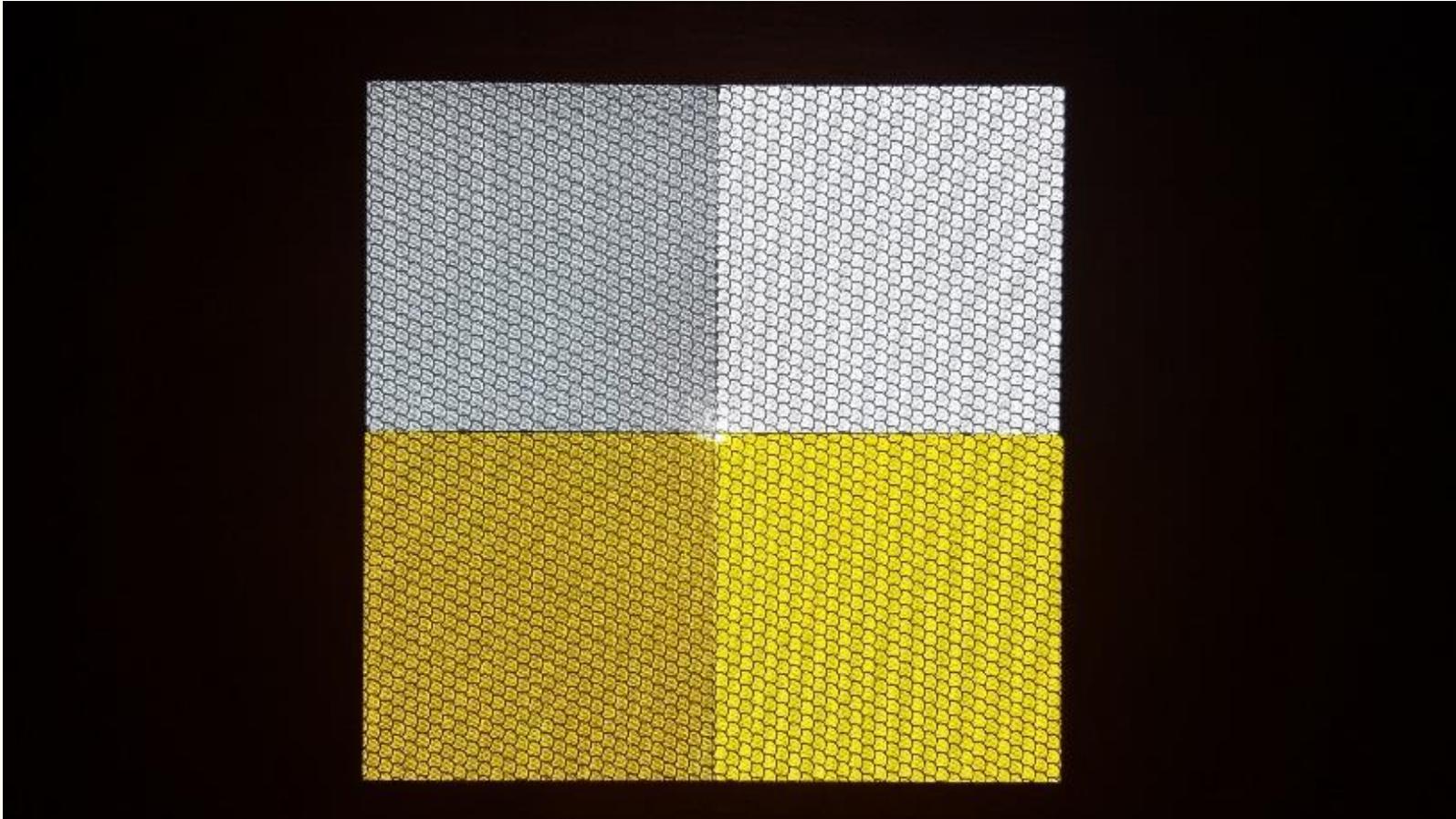
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100 cd/lux/m² Difference (100 vs 200)



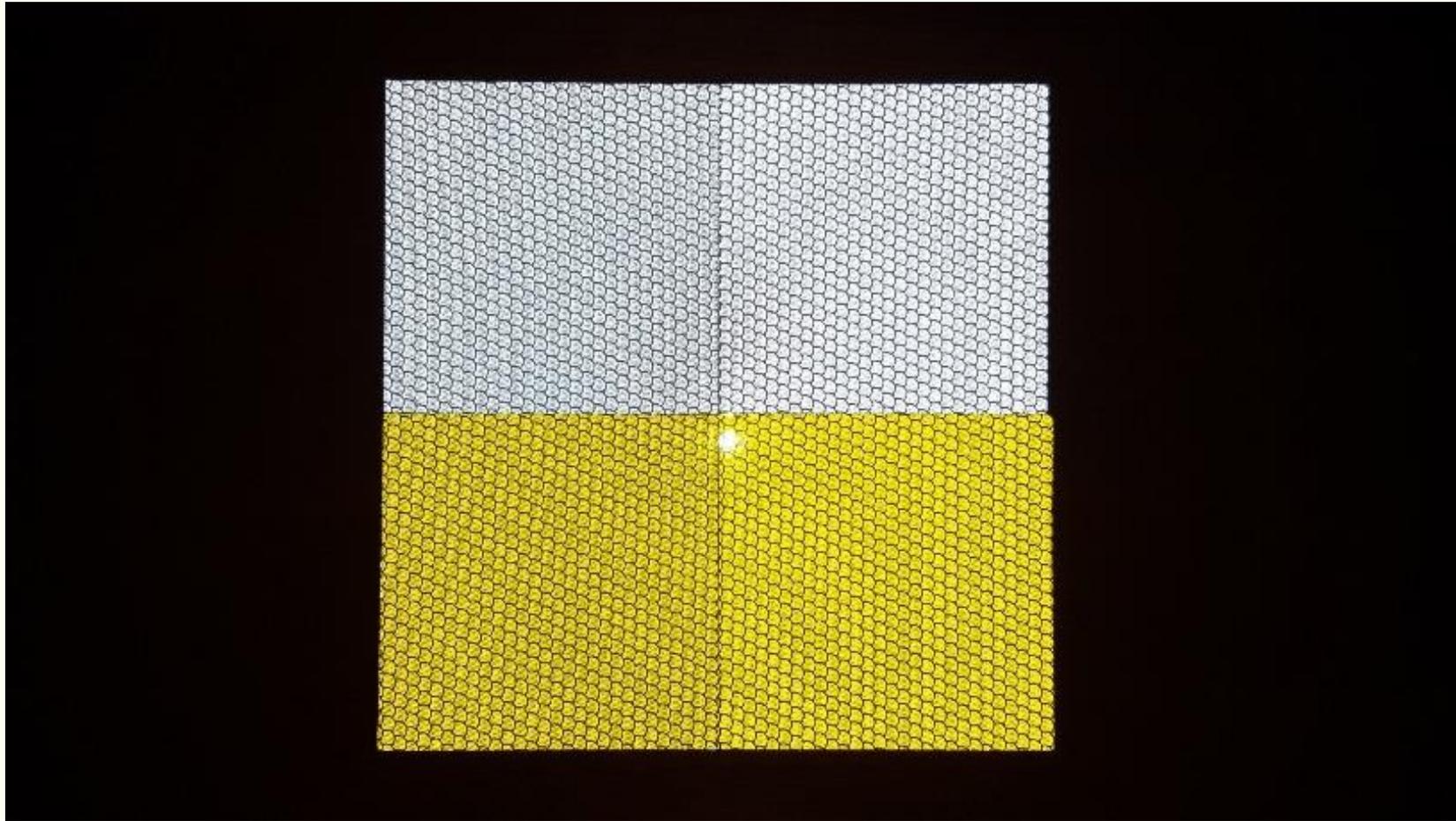
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50 cd/lux/m² Difference (150 vs 200)



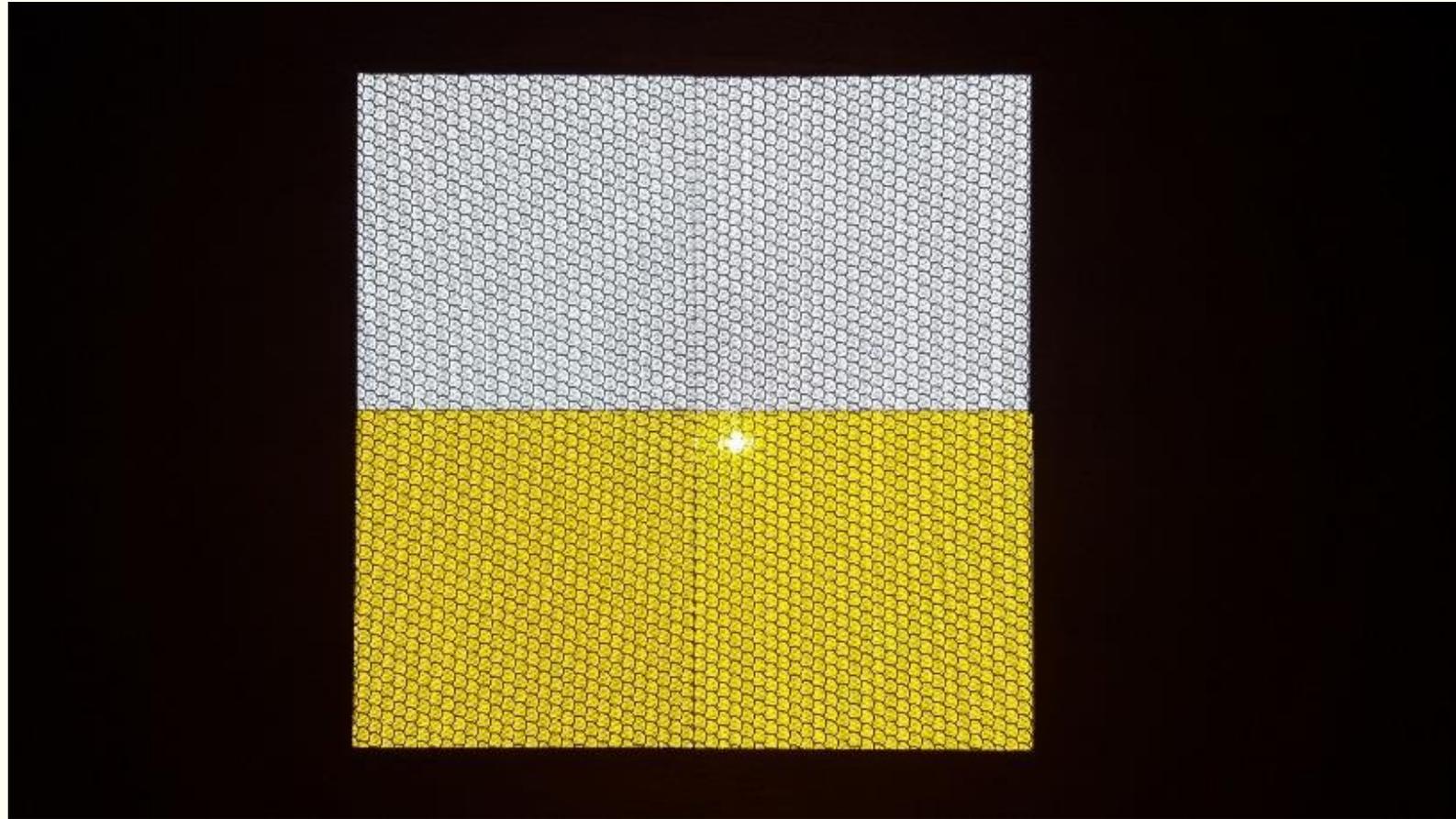
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20 cd/lux/m² Difference (150 vs 170)



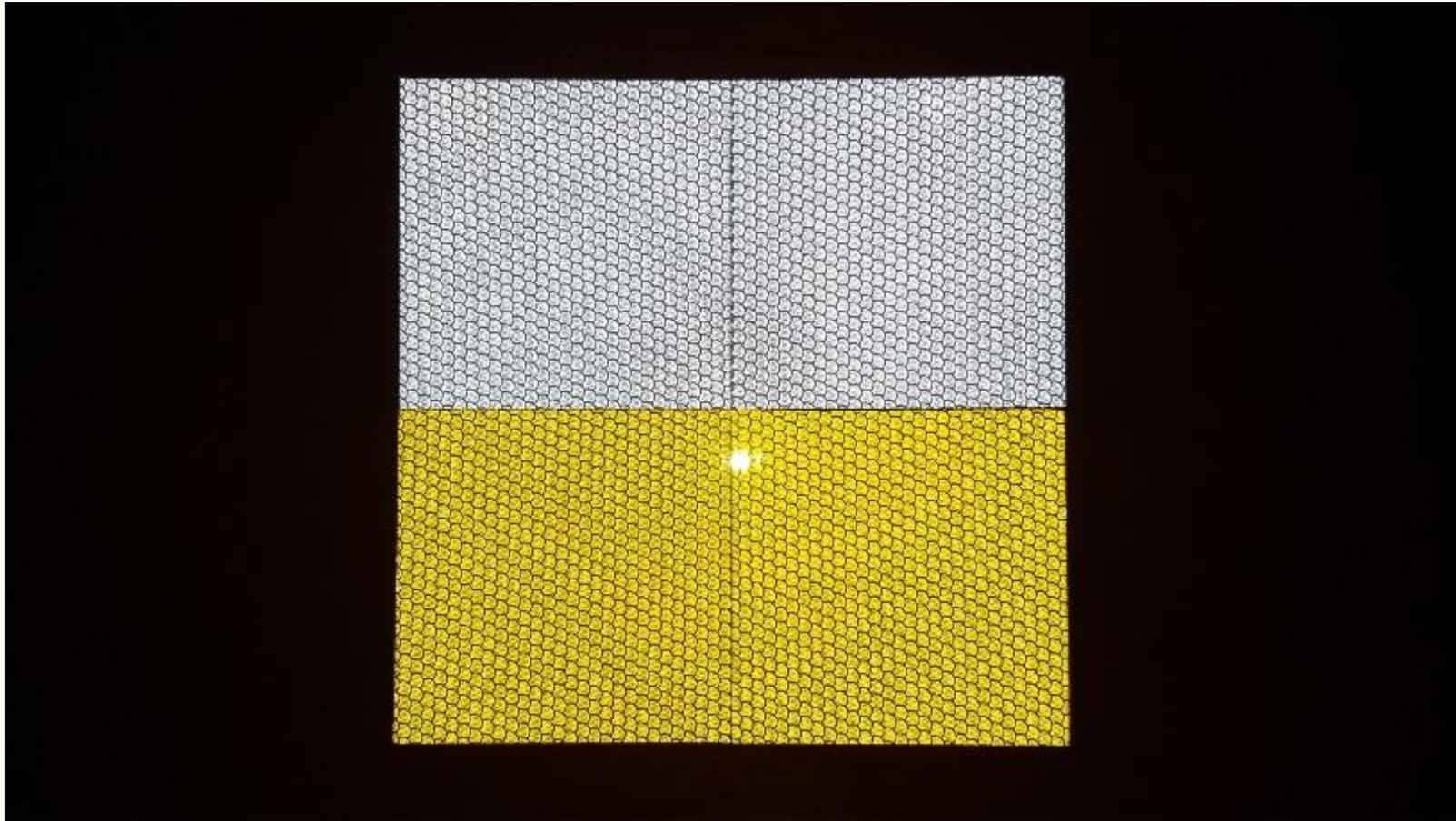
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10 cd/lux/m² Difference (150 vs 160)



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Addendum D

Employee Instructions

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Example Employee Instructions

Reflectivity Inspection Procedure

Initial Inspection

Employees responsible for performing an annual locomotive inspection or a single car air brake test must inspect each piece of reflective material on the car/locomotive as follows:

1. Reflective sheets must be cleaned.
2. Examine each sheet on the car/locomotive from a uniform distance (15ft preferred) with a light source to ensure:
 - a) there is no internal failure
 - b) it is not in condemnable degradation (i.e. dark, non-reflecting portions), or
 - c) it is not completely obscured
3. Each reflective sheet which does not pass this inspection must be renewed or have a Performance Inspection conducted.

Performance Inspection

1. Verify Comparator Panel is within one year of the calibration or manufacture date.
2. Select a distance which can be maintained for inspection of all reflective sheets on the car/locomotive
3. For each reflective sheet:
 - a) place the panel over the center of the reflective sheet
 - b) hold the light source adjacent to your eye straight out from the side of the car/locomotive
 - c) compare the reflected light intensity of the reflector to that of the panel.
4. If, on more than 20% of the reflective panel:
 - a) the reflected light intensity difference between the reflective sheet and Comparator Panel cannot be discerned, or
 - b) the Comparator Panel is more reflective than the reflective sheetthe reflective sheet(s) which did not pass inspection must be replaced and bill why made code 1F (Does not meet minimum reflectivity levels).