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Supplementary Notes

Abstract

A very high-brightness reflective sheeting material was introduced in 1994 as a possible alternative to illumination. Several new products have emerged with a similar claim of superior retro-reflectivity properties when compared to traditional sheeting materials.

A demonstration project was developed to assess the comparable performance of these materials and determine the minimum sign sheeting requirements for non-illuminated overhead signs.

Based on this demonstration it is recommended that the department continue to specify using 3M's Diamond Grade (VIP) series 3990 as a proven product for use on overhead signs and for other specialized signing requirements.

Key Words	Distribution Unlimited
Non-illuminated Overhead Signs Retro-reflectivity Reflective Sheeting Traffic Control Devices	Project Co-ordinator Terry Willis, P. Eng.

ALBERTA INFRASTRUCTURE

Demonstration Project:
Sheeting Material Requirements for Non-Illuminated Overhead Signs

INTRODUCTION

The increasing cost of installation, maintenance, rehabilitation and operating costs for illuminated overhead sign structures is a concern for several Alberta Infrastructure, Operations Managers.

A very high-brightness reflective sheeting material was introduced in 1994 as a possible alternative to illumination. Since then several new products have emerged with a similar claim of superior retro-reflectivity properties when compared to traditional sheeting materials that were used in the past.

A demonstration project was developed in order to assess the comparable performance of these materials and determine the minimum sign sheeting requirements for non-illuminated overhead signs.

OBJECTIVES

The objectives of this project are:

1. Evaluate the performance of 3M Diamond Grade (LDP series 3970 & VIP series 3990) and Stimsonite 6200 High–Performance retro-reflective sheeting for traffic control on non-illuminated overhead signs.
2. Develop an AI standard for minimum retro-reflectivity and performance requirements.
3. Evaluate the long-term performance of these materials.

BACKGROUND

General

Since 1954 the Manual on Uniform Traffic Control Devices (MUTCD) has required that signs and pavement markings be reflectorized or illuminated. However it contained no minimum in-service retro-reflective requirements for signs and markings. In 1985, FHWA requested comments regarding rulemaking considerations on the issue of retro-reflectivity of traffic control devices. It was concluded that research was required before any meaningful revisions to the standard could be proposed.

Congress, in 1993 directed the FHWA to develop retro-reflectivity standards for signs and pavement markings.

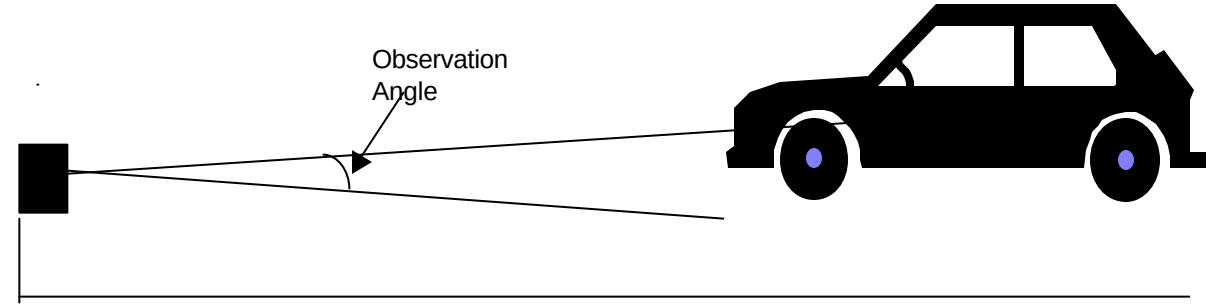
Congress, in 1999 passed a Policy Resolution, PR-17-98, “Minimum Retro-reflectivity of Traffic Control Devices that requires a task group be appointed by the chair of the Standing Committee on Highways (SCOH). Representatives from SCOH and other appropriate highway subcommittees will work in partnership with the private sector, other interests, and FHWA, to review the research findings of sign retro-reflectivity. The FHWA is requested to refrain from initiating rulemaking on this matter until such cooperative review of the research is achieved.”

At the time of writing this report no reports, standards or minimum requirements have been presented.

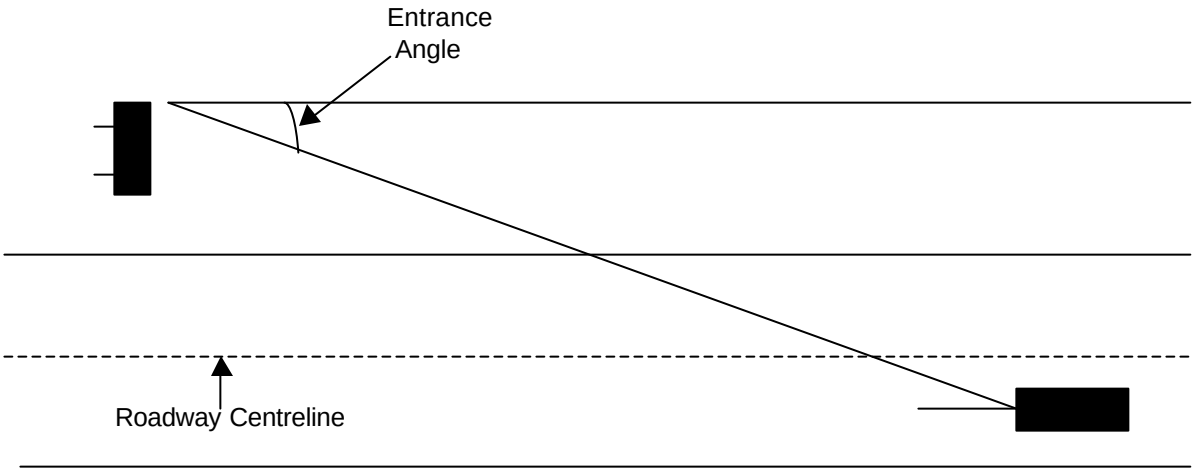
Retro-reflective Sheeting Requirements (Observation and Entrance Angles)
The basis of the ASTM standard D 4956 is related to the performance of retro-reflective sheeting as a function of both the entrance and observation angles of the source of light.

The +30 degree entrance angle has traditionally been considered to be the widest angle at which a sign mounted on the right shoulder would commonly be seen on curved roadways.

The observation angle is the angle between a light beam striking the surface of the sign and the line of sight of the driver. This angle is a function of the height of the driver's eyes with respect to the vehicle headlamp. A 0.2 degree observation angle is used to represent a standard passenger vehicle and a 0.5 degree observation angle is used to represent a standard truck.



The entrance angle is the angle between a light beam striking the surface of the sign and a line perpendicular to the sign surface.



The angles used represent the distance when a vehicle is of about 250 metres from the sign. Both the entrance angle and observation angle increase as the vehicle approaches the sign or the location of the sign is not located on the right shoulder.

Desirable performance requirements for sign sheeting material

The performance of all reflective signs depends upon the amount of light provided by the headlamps of approaching vehicles. Because headlamps are aimed to minimize offending glare from oncoming vehicles, signs on the right shoulder receive significantly more light than signs located to the left of the roadway or overhead.

Studies show that for a vehicle travelling in the right lane a sign on the left shoulder receives 78% less light than a sign on the right hand shoulder at a distance of 200 m. Overhead signs receive even less light from vehicle headlights, 86% to 83% less for left hand lane and same lane overhead signs respectively.

It is obvious that signs will show less reflective brightness when mounted in positions other than the right shoulder and current standards do not take these increased angles into consideration. Accepting a material based on the results of laboratory testing and performance on the right shoulder can be challenged.

Research has determined that it requires 10-15 seconds for a motorist to notice and respond to a potential hazard.

100 kph = 268 to 400 metres

400 m	268 m		120 m		
	1.5 – 3 seconds		4.2 – 7.1 seconds		4.5 seconds
Visible	Sees	Recognize Hazard	Decides on Action	Initiates Action	Completes Manoeuvre

It is therefore desirable to have the following performance characteristics sustained from a distance of about 400 m and remain constant until last look for proper traffic management.

- Ability to deliver continuous conspicuity for all vehicles types regardless of sign placement
- Luminance should be constant over the entire approach
- Should be visible at wide approach angles within the 400 to 268 m range
- Must be clear and legible with no drop off at closer distances
- Provides the driver with the opportunity to notice, read and respond to the sign in order to provide the greatest benefit to drivers battling fatigue, lights, poor vision, bad weather or unfamiliar roadway geometrics.

Alberta Experience

In 1994 the overhead sign on Hwy. 2, NBL (Gasoline Alley), Red Deer, Alberta was replaced with 3M Diamond Grade (VIP) series 3990 sheeting material. This was a test site for using non-illuminated overhead signs.

Subsequently several overhead signs have been replaced with 3M Diamond Grade (VIP) series 3990 sheeting material based on the acceptance of the Gasoline Alley test.

There now exists several highway sign sheeting materials that significantly exceed the minimum retro-reflectivity requirements for ASTM D 4956, Type III, High Intensity sheeting material (Appendix A). Therefore a demonstration project was initiated in order to determine and/or establish minimum retro-reflectivity requirements and performance standards based on an in-service evaluation.

DEMONSTRATION PROJECT

Demonstration Project Details

Signs were fabricated under Contract No. 5778/96 by Alberta Traffic Supply for Alberta North Highway Services Limited. Allan Russell (ATS) provided initial retro-reflectivity readings using a hand-held retroreflectometre for all materials incorporated in the manufacturing of the signs.

Table 1 Retro-reflectivity Readings:

COLOUR	3M		Stimsonite	ASTM Type III (3M HI)
	VIP 3990	LDP 3970	HP 6200	
White	516(370)*	1330(800)	1080(683)	298(250)
Green	72(45)	141(80)	81(89)	55(45)
Contrast Ratio (W/G)	7.1	13.3	9.4	5.4

* Numbers in brackets are the manufacturers minimum standards for the series indicated. (Retro-reflectivity values are based on an Observation angle of 0.2º and an Entrance angle of -4º.)

The signs were manufactured such that the left sign, “Hwy. 13 Winfield” uses 3M Diamond Grade (VIP) series 3990, the middle sign, “Hwy 2 Red Deer” uses Stimsonite 6200 High-Performance, and the right sign, “Hwy. 2 Edmonton” uses 3M Diamond Grade (LDP) series 3970.

Installation was carried out on November 11, 1999 by Alberta North Highway Services Limited under the direction of Dale Rimmer, MCI, Ponoka.

In-Service Evaluation:
Day-time evaluations were carried out to base line the general layout of the site and to note any additional factors that may impact the overall performance of the materials.

The night-time evaluation was carried out as follows:

1. Photos were taken at about 750, 500, 250, 100 and 50 metres
2. luminance rating by ordinal (1, 2, 3)
3. constant sustained illumination by ordinal (1, 2, 3)
4. visual acuity (legibility) by ordinal (1, 2, 3)
5. contrast rating (Sharpness) by ordinal (1, 2, 3)

FIELD OBSERVATIONS

Day-Time Inspection November 30, 1999 (Ted Harrison, Joe Filice, Allan Russell)
The general appearance of all three signs was similar in colour and over all performance.

Night-Time Inspection November 30,1999 (Ted Harrison, Joe Filice, Allan Russell)
It was difficult to obtain a continuous uninterrupted viewing due to oncoming traffic.

Initial observations are as follows:
On low beams

- The 6200 HP and 3970 LDP provide the best and similar performance at first detection
- All three signs appear to be similar in brightness and clarity at the legibility and last look
- Any difference in the appearance are representative of the contrast ratios between the white lettering and green background (see Table 1) The higher the contrast ratio the more visible the lettering at first detect. The higher brightness levels did not appear to wash out or distort the appearance of the letters
- It was noted that the 6200 HP and 3970 LDP appeared to drop off and then reappear at various distances during the viewing period
- It was also agreed that all products would not provide adequate traffic management during inclement weather or adverse environmental conditions (i.e. fog, rain, snow or smoke)

On high beams

- All signs provide similar performance from first detect to last look. Because this site is on very level terrain the first detect was about 1.5 kilometres if not more.
- Performance was equal to the advance information high intensity sign located on the right shoulder.

Night-Time Inspection December 31, 1999 (Dale Rimmer)
Photos were taken with a digital camera at 5:30 a.m. at 750, 500, 250, 100 and 50 metres with high beams (see Appendix C).

It was noted that the two O's in Edmonton, on the 3M LDP series 3970, did not appear to be from the same material. Allan Russell confirmed that the same material was used but the material had been rotated 90 º and therefore has different properties. The structure of these high brightness micropristamic materials requires that they be oriented in a specified direction.

It should be noted that the standard test results are carried out at both 0 and 90º and will provide similar results. The products are designed to meet the requirements of the test they do not assure uniform performance at all angles.

Day-Time Inspection October 17, 2000 (Ted Harrison)
Photos were taken with a 35 mm camera, at 1:00 p.m. at 1500, 1000, 750, 500, 250, 100 and 50 metres, in order to provide a comparison to the night-time photos (see Appendix C).

Nigh-Time Inspection November 02, 2000 (Ted Harrison, Joe Filice)
Both digital and 35 mm photos were taken at 10 p.m. at 1500, 1000, 750, 500, 250, 100 and 50 metres with low beams (see Appendix C).

Field Comments
Red Deer has converted or installed four overhead signs where illumination has been removed or not installed. To date, no complaints have been received from the public.

The overall view time is reduced on the signs on low beam. The signs are only visible when there is sufficient light from the headlamps. This fact reduces the viewing time "window".

As a general rule, most of the sites have been on vertical curve crests, which increase the viewing window. Signs located at vertical curve sag may not provide an adequate viewing time and should not be considered as a suitable candidate for non-illuminated sign installation.

Based on in-service performance the 3M VIP series 3990 are clearly visible and provide acceptable night time traffic management although the viewing time is less than that of an illuminated sign.

RESULTS OF NIGHT-TIME EVALUATION

A Night-Time In-Service Rating form was developed to provide an evaluation based on an ordinal system along with an overall performance indicator of Acceptable, Somewhat

Acceptable, Somewhat Unacceptable and Unacceptable.

Results of the night-time in-service ratings are presented in Appendix B.

The following summary provides an overall performance score based on the sum of the ratings. A perfect score for rating 1 in all 19 categories is 19 and the worst score of 57 would be achieved if the placement of 3 were given in each category.

Table 2
Night-Time In-Service Rating
Summary

	VIP 3990	6200 HP	LDP 3970
# First Place Ratings	**16**	**6**	**3**
# Second Place Ratings	**0**	**13**	**9**
# Third Place ratings	**3**	**0**	**7**
Score (19-57)	**25**	**32**	**42**
# Acceptable	**4**	**2**	**1**
# Somewhat Accept.	**0**	**3**	**2**
# Somewhat Unaccept.	**1**	**0**	**0**
# Unacceptable	**0**	**0**	**2**

DISCUSSION OF RESULTS

The observations and evaluations are qualitative and not quantitative in nature and will vary based on the experience of the evaluator. The overall consensus from the in-service evaluation is that only one product, 3M's (VIP) series 3990, provided the minimum acceptable performance for night-time traffic management.

The benefits of using sheeting materials with very high-brightness do not appear to provide acceptable performance characteristics over the entire viewing period.

3M's (VIP) series 3990 has higher retro-reflectivity values when compared to traditional High-Intensity products but also provides improved performance characteristics over the entire viewing period.

CONCLUSIONS AND RECOMMENDATIONS

Based on this demonstration it is recommended that the department continue to specify using 3M's Diamond Grade (VIP) series 3990 as a proven product for use on overhead signs and

for other specialized signing requirements.

The service life is expected to be similar to the traditional products currently in use by the department.

This demonstration site will remain as is in order to allow AI personal, Consultants, and sign manufacturers the opportunity to evaluate and provide feedback to the department. In the long-term it will assist in establishing a standard and life-cycle costs for retro-reflective sheeting materials used on non-illuminated overhead signs.

ACKNOWLEDGEMENTS

Mr. Dale Rimmer, Maintenance Contract Inspector, Alberta Infrastructure
Mr. Alan Griffith, Operations Manager, Alberta Infrastructure
Mr. Allan Russell, Alberta Traffic Supply Ltd
Mr. Joe Filice, Materials Technologist, Alberta Infrastructure

APPENDIX A

Existing Retro-reflectivity Standards (ASTM D4956, Hi-Intensity Type III)
The following table compares the manufacturer's specification requirements for their very high-brightness microprismatic sheeting materials ASTM D4956 (Type III).

WHITE

Angle		3M		Avery* Dennison	ASTM Type III
Observation	**Entrance**	**VIP 3990**	**LDP 3970**	**T-7000**	
0.2	-4	370	800	610	250
	+30	225	400	280	150
0.5	-4	275	200	250	95
	+30	125	100	135	65

Green

Angle		3M		Avery Dennison	ASTM Type III
Observation	**Entrance**	**VIP 3990**	**LDP 3970**	**T-7000**	
0.2	-4	45	80	73	45
	+30	28	ND	32	25
0.5	-4	32	ND	30	15
	+30	16	ND	15	10

Red

Angle		3M		Avery Dennison	ASTM Type III
Observation	**Entrance**	**VIP 3990**	**LDP 3970**	**T-7000**	
0.2	-4	98	315	115	45
	+30	65	100	48	25
0.5	-4	70	45	55	15
	+30	32	26	27	10

* Stimsonite now Avery Dennison (Product line renamed form 6200 High Performance to T-7000 Prismatic Grade Sheeting.

APPENDIX B

Night-Time In-Service Rating
750 Metres

	VIP 3990	6200 HP	LDP 3970
Luminance Rating (1,2,3)	**3**	**1**	**2**
Comments			
Constant Sustained Illumination (1,2,3)	**N/A**	**N/A**	**N/A**
Comments	**First Look**	**First Look**	**First Look**
Visual Acuity (legible) (1,2,3)	**3**	**1**	**2**
Comments			
Contrast Rating (Sharpness) (1,2,3)	**3**	**1**	**2**
Comments			
Acceptable	•	**X**	•
Somewhat Acceptable	•	•	**X**
Somewhat Unacceptable	**X**	•	•
Unacceptable	•	•	•
Comments			

Night-Time In-Service Rating
500 Metres

	VIP 3990	6200 HP	LDP 3970
Luminance Rating (1,2,3)	**1**	**2**	**3**
Comments			
Constant Sustained Illumination (1,2,3)	**1**	**2**	**3**
Comments	**Constant**	**Decrease**	**Decrease**
Visual Acuity (legible) (1,2,3)	**1**	**2**	**3**
Comments			
Contrast Rating (Sharpness) (1,2,3)	**1**	**2**	**3**
Comments			
Acceptable	**X**	•	•
Somewhat Acceptable	•	**X**	•
Somewhat Unacceptable	•	•	•
Unacceptable	•	•	**X**
Comments			

Night-Time In-Service Rating
250 Metres

	VIP 3990	6200 HP	LDP 3970
Luminance Rating (1,2,3)	**1**	**2**	**3**
Comments			
Constant Sustained Illumination (1,2,3)	**1**	**2**	**2**
Comments	**Constant**	**Constant**	**Constant**
Visual Acuity (legible) (1,2,3)	**1**	**2**	**3**
Comments			
Contrast Rating (Sharpness) (1,2,3)	**1**	**2**	**3**
Comments			
Acceptable	**X**	•	•
Somewhat Acceptable	•	**X**	•
Somewhat Unacceptable	•	•	•
Unacceptable	•	•	**X**
Comments			

Night-Time In-Service Rating
100 Metres

	VIP 3990	6200 HP	LDP 3970
Luminance Rating (1,2,3)	**1**	**1**	**1**
Comments			
Constant Sustained Illumination (1,2,3)	**1**	**2**	**2**
Comments	**Constant**	**Increase**	**Increase**
Visual Acuity (legible) (1,2,3)	**1**	**1**	**1**
Comments			
Contrast Rating (Sharpness) (1,2,3)	**1**	**1**	**1**
Comments			
Acceptable	**X**	**X**	**X**
Somewhat Acceptable	•	•	•
Somewhat Unacceptable	•	•	•
Unacceptable	•	•	•
Comments			

Night-Time In-Service Rating
50 Metres

	VIP 3990	6200 HP	LDP 3970
Luminance Rating (1,2,3)	**1**	**2**	**2**
Comments			
Constant Sustained Illumination (1,2,3)	**1**	**2**	**2**
Comments	**Constant**	**Decrease**	**Decrease**
Visual Acuity (legible) (1,2,3)	**1**	**2**	**2**
Comments			
Contrast Rating (Sharpness) (1,2,3)	**1**	**2**	**2**
Comments			
Acceptable	**X**	•	•
Somewhat Acceptable	•	**X**	**X**
Somewhat Unacceptable	•	•	•
Unacceptable	•	•	•
Comments			

APPENDIX C

PHOTO LOG

Day-Time Inspection: October 17, 2000 Night-Time Inspection: November 02, 2000 (Low Beams, Digital Camera no zoom)		
Distance from Structure	**Day-time**	**Night-time**
1 500 metres	No detection	Overhead sign is very faint but is due to vehicle ahead switching to high beams at time of photo
1 250 metres	No detection	No detection
1 000 metres	No detection	No detection
750 metres	Structure and right shoulder information sign detected	Right shoulder information sign very faint No overhead sign detected
500 metres	Right shoulder information and overhead signs visible	Right shoulder information sign visible Overhead sign very faint
325 metres	Right shoulder information sign legible Overhead sign visible but not legible	Right shoulder information sign legible Overhead sign visible but not legible
250 metres	Right shoulder information sign (last-look) Overhead sign visible but not legible	Right shoulder information sign (last-look) Overhead sign visible but not legible
Top of Lane Division	Overhead legible	Overhead sign legible
Start of Guardrail	Overhead sign visible but not legible	Left sign legible Middle sign faint Right sign poor

Night-Time Inspection: December 31, 1999 (High Beams, Digital Camera with zoom)			
	Night-Time		
	Left Sign	**Middle Sign**	**Right Sign**
750 metres	Faint	Good	Good
500 metres	Good	Faint	Faint
250 metres	Good	Faint	Faint
100 metres	Good	Good	Good
50 metres	Good	Faint	Faint

Day-Time Inspection: October 17, 2000
Night-Time Inspection: November 02, 2000


1500 metres


1250 metres


1000 metres


750 metres

Day-Time Inspection: October 17, 2000
Night-Time Inspection: November 02, 2000

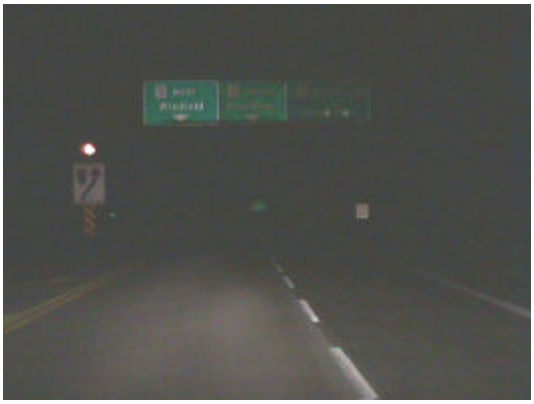

500 metres


325 metres


250 metres


Top of Lane Division

Start of Guardrail Outer Lane



Start of Guardrail Inner Lane

750 metres

500 metres

250 m

100 metres

50 metres