

Research Report
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**A SURVEY ON REFLECTIVE SHEETING
FOR HIGHWAY SIGNS**

KYP-72-31, HPR-1(8), Part III

by

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A SURVEY ON REFLECTIVE SHEETING FOR HIGHWAY SIGNS

A questionnaire (see the APPENDIX) was sent to highway agencies in all 50 states, the District of Columbia and Puerto Rico for the purpose of surveying state practices in regard to reflective sheeting purchase, usage specifications, testing, etc. The response was 100 percent and, thus, demonstrated a high degree of interest in the subject.

Responses to the questionnaire are tabulated on the attached tables. An attempt was made to report answers provided by the agencies without interpretation except in a few isolated cases where the necessary information was available to properly relate the response to a given question. In a few instances, the agency was contacted for additional information or clarifications.

A detailed analysis of information obtained from the questionnaire, copies of specifications and purchase requisitions submitted by the respondents is intently omitted here. Instead, each contributor is invited to review the attached tables and to extract whatever information may be of value. However, the commentary and summary of findings, which follows, may be of interest.

1. Except for two states, purchases of reflective sheeting were governed by specifications. Specifications were established from a combination of agency experience and testing, manufacturers' recommendations or L-S-300A. Only nine agencies indicated exclusive dependence upon manufacturer specifications, but the majority of agencies incorporated minimum brightness values as specified by the manufacturer. Nineteen states planned to update or amend specifications in the near future - particularly in regard to reflectivity requirements.
2. Forty states award contracts from sealed bids. The remaining states issue contracts or purchase requisitions to the manufacturer by product designation, as a single source of supply.
3. The majority of states require reflective sheeting to pre-qualify as an acceptable product either by in-house testing or by manufacturer's certification of product compliance with specifications. Only 23 states conduct in-house testing and evaluations.
4. Twenty-one agencies do not conduct tests on samples from individual shipments of materials. Of those which conduct tests in-house, most check the material for color requirements; only 23 agencies test for reflectivity.

5. During Fiscal Years 1971 and 1972, the Minnesota Mining and Manufacturing Company (3M) was the exclusive supplier of reflective sheeting materials for routine purposes to all states except Texas, which purchased most of its yellow and silver-white sheeting and prepared sign faces (red) from the Americal Decal and Manufacturing Company. Limited quantities of sheeting were purchased mainly for experimental purposes by ten other states from manufacturers listed below:

Manufacturer	Brand Name
American Decal & Mfg. Co.	Adcolite
Fasson Products	FasCal
Morgan Adhesives Co. (MACtac)	MACLite
Sun Chemical Co.	Sun-Lite

6. The states were about evenly divided on expressing the need for materials equal to or brighter than the High-Intensity Scotchlite (encapsulated lens type -- silver white and green). Those responding positively (21 states) were also using the materials. Its usage, however, was not always specified. A number of states indicated limited usage either for sign legends, interstate guide signs, overhead signs, large shoulder-mounted signs, or experimental purposes. The high-intensity materials are used extensively by Louisiana (since 1968 for all overhead and large ground-mounted signs on both interstate and other primary highways), Tennessee and perhaps others (not clearly discernable from the responses).

Many agencies (13 states) which responded negatively to the question of need for high-intensity materials indicated, nevertheless, interest in the materials by experimental installations and use in legends and specific sign types.

7. A vast majority of states illuminate overhead signs, but those that do not (or for signs which are not illuminated) have recognized the need for brighter materials such as buttons or high-intensity materials in sign legends.

State	Use Specifications		Source of Specifications			Plan to Update Specifications			Award Contr. from Bids		Prequalify Materials				Test Shipments			State	
	YES	NO	Agency Exp. and Testing	Mfg.	Fed. L. S. 300A	YES-Ref.	NO	YES	NO	YES			NO						
										In-House	Ind. Test Lab.	Mfg. Cert.	Reflectivity	Color	Other				
Alabama	X			X	X	X	X	X		X		X		X	X ^{1,2}	X		Alabama	
Alaska	X		X				X	X			X						X	Alaska	
Arizona	X		X	X		X	X		X			X					X	Arizona	
Arkansas	X		X	X			X	X			X							X	Arkansas
California	X		X	X		X	X		X	X				X	X ^{1,2}	X		California	
Colorado	X		X		X		X		X	X								X	Colorado
Connecticut	X				X		X	X			X							X	Connecticut
Delaware	X					X	X				X				X ¹				Delaware
Dist. of Columbia	X		X	X		X	X		X			X						X	Dist. of Columbia
Florida	X		X	X		X	X		X	X	X		X	X ^{1,2}					Florida
Georgia	X		X	X			X		X	X	X		X	X ^{1,2}					Georgia
Hawaii	X		X	X		X	X					X						X	Hawaii
Idaho	X		X			X	X		X	X				X	X ¹	X			Idaho
Illinois	X		X	X		X	X		X		X		X	X ¹	X				Illinois
Indiana	X		X	X		X		X			X			X ²					Indiana
Iowa	X		X				X	X		X				X	X ¹	X			Iowa
Kansas	X		X	X		X	X		X	X				X ¹	X				Kansas
Kentucky	X		X	X		X	X		X	X				X ¹	X				Kentucky
Louisiana	X		X	X			X	X		X	X	X		X	X				Louisiana
Maine	X		X	X			X	X			X							X	Maine
Maryland	X		X				X	X		X				X ²					Maryland
Massachusetts	X			X		X	X		X			X		X	X	X			Massachusetts
Michigan	X		X			X	X		X			X		X	X ^{1,2}	X			Michigan
Minnesota	X		X	X		X	X		X	X	X			X	X ¹				Minnesota
Mississippi	X		X	X			X	X				X			X ¹				Mississippi
Missouri	X		X				X		X	X				X	X ¹	X			Missouri
Montana	X		X	X		X	X		X			X			X ¹	X			Montana
Nebraska	X		X	X			X	X		X								X	Nebraska
Nevada	X		X				X					X						X	Nevada
New Hampshire	X		X				X		X									X	New Hampshire
New Jersey	X		X	X			X	X		X				X	X ¹				New Jersey
New Mexico	X		X				X	X				X			X ¹				New Mexico
New York	X		X	X			X	X		X				X	X ¹	X			New York
North Carolina	X		X	X		X			X			X						X	North Carolina
North Dakota	X		X	X					X			X						X	North Dakota
Ohio	X		X	X			X	X				X						X	Ohio
Oklahoma	X		X	X			X	X		X		X		X	X				Oklahoma
Oregon	X		X				X	X				X		X	X ¹				Oregon
Pennsylvania	X		X	X			X	X				X		X	X ¹				Pennsylvania
Puerto Rico	X		X	X			X	X		X			X	X	X ^{1,2}				Puerto Rico
Rhode Island	X		X			X	X		X			X			X ¹				Rhode Island
South Carolina		X							X				X					X	South Carolina
South Dakota	X		X	X		X	X		X			X						X	South Dakota
Tennessee	X		X				X	X				X						X	Tennessee
Texas	X		X			X		X				X		X	X	X			Texas
Utah	X		X	X			X	X		X			X	X	X ²	X			Utah
Vermont	X		X	X					X			X			X ¹				Vermont
Virginia	X		X			X	X		X		X							X	Virginia
Washington	X		X				X		X		X							X	Washington
West Virginia	X		X	X			X	X		X		X		X	X ¹				West Virginia
Wisconsin		X							X		X							X	Wisconsin
Wyoming	X		X				X		X									X	Wyoming
Total:	50	2	28	41	29	19	13	30	40	11	23	5	20	15	23	31	14	21	Total

* 1-visual test
2-instrumental test

State	Mfg.	Principle Source of Materials								Other Sources of Recently Purchased Materials				State	
		Quantities Purchased (sq. ft.) - Enclosed Lens Type Materials				1972				Manufacturer and/or Trade Name	Color	Quantities (sq. ft.)	Reasons for Purchase		Evaluation or Comments
		1971	Yellow	Green	S. White	Blue	Yellow	Green	S. White						
Alabama	3M	24,750	9,000	78,000		34,350	4,500	66,660							Alabama
Alaska	3M	18,000	1,500	12,000		18,000	1,500	12,000							Alaska
Arizona	3M	73,400	25,950	92,800	400	74,800	34,350	95,900	1,950						Arizona
Arkansas	3M			(1971-72 FY)		38,550	26,238	123,900	2,600						Arkansas
California	3M			(1971-72 FY)		83,000	0	97,400							California
Colorado	3M	19,500	12,500	49,500	1,500	19,500	12,500	49,500	1,500						Colorado
Connecticut	3M	5,100 yds	700 yds	3,500 yds	550 yds										Connecticut
Delaware	3M			(total - 75,000)				(total - 60,000)							Delaware
Dist. of Columbia	3M	2,250	9,225	13,230	1,125	2,500	10,150	14,550	1,250						Dist. of Columbia
Florida	3M			(total - \$100,000 per year)						Fascon Products (FasCal) and MACtac (MACLite)		\$6,000 (appr.)	experimental		Florida
Georgia	3M					16,200	8,400	149,250	1,800						Georgia
Hawaii	3M	2,250	500	2,300	450	1,350	1,200	6,750	300						Hawaii
Idaho	3M	20,000		25,000	500	25,000	500	35,000	1,000						Idaho
Illinois	3M	19,650	35,850	120,600	1,200					American Decal (Adcolite)	orange	7,200			Illinois
Indiana	3M	42,000	18,000	205,000	4,000	40,000	22,000	112,000	6,000						Indiana
Iowa	3M					50,000		35,000	3,000						Iowa
Kansas	3M	28,500	12,600	81,750	1,050	18,900	36,600	64,650	300						Kansas
Kentucky	3M	231,400	1,500	233,345	1,500	100,645	40,000	73,230	4,125						Kentucky
Louisiana	3M	89,000	36,025	120,395	1,500	29,000	12,150	54,635	0						Louisiana
Maine	3M	70,000	5,000	25,000	2,500	75,000	8,000	30,000	3,000						Maine
Maryland	3M	15,000	30,000	62,000		24,000	30,000	80,000	4,000						Maryland
Massachusetts	3M			(Approximately the same as FY '72)		31,950	16,950	70,517	2,100						Massachusetts
Michigan	3M	37,825	69,350	112,932	7,900	80,753	87,951	152,924	9,450	American Decal (Adcolite)	s. white, yellow, green	1,200	lab tests and experimental	Evaluation incomplete	Michigan
Minnesota	3M	19,425	60,000	52,000	4,500	21,775	52,275	72,675	5,400						Minnesota
Mississippi	3M														Mississippi
Missouri	3M	111,900	4,800	303,700	900	49,500	4,200	206,500	9,750						Missouri
Montana	3M														Montana
Nebraska	3M	75,000	41,000	153,000	1,000	35,000	42,000	84,000	44,000	American Decal (Adcolite)		test samples	experimental	Rated comparable to 3M Commercial Grade	Nebraska
Nevada	3M	17,000	22,000	22,000	2,000	17,000	22,000	22,000	2,000						Nevada
New Hampshire	3M					34,050	7,800	29,225	825						New Hampshire
New Jersey	3M	25,875	1,200	63,500	1,300	19,875		50,400	375						New Jersey
New Mexico	3M														New Mexico
New York	3M	121,000	22,000	125,000	2,000	7,000	19,000	139,000	4,000						New York
North Carolina	3M	201,250	143,750	28,750	201,250	222,275	158,120	30,200	222,275	American Decal (Adcolite) Sun Chemical (Sun-Lite)	yellow, s. white	6,000 6,000			North Carolina
North Dakota	3M														North Dakota
Ohio	3M			(1971-72 FY Combined)		250,000	60,000	400,000	25,000	MACtac (MACLite)	green, orange, yellow, silver	240	Experimental	Haven't had time to evaluate	Ohio
Oklahoma	3M														Oklahoma
Oregon	3M	36,149	42,336	14,550	301	12,750	27,713	7,800	962						Oregon
Pennsylvania	3M			(FY 71 + FY 72)		310,875	31,875	300,975	3,000						Pennsylvania
Puerto Rico	3M	600		6,300	3,600	11,250	26,100	34,800							Puerto Rico
Rhode Island	3M	1,000	3,000	3,000	1,000										Rhode Island
South Carolina	3M	6,000	300	23,175	2,100	3,000	900	19,650							South Carolina
South Dakota	3M	7,500	6,000	13,500	300	9,000	7,500	15,000	600						South Dakota
Tennessee	3M					(Total 116,278 in all colors)									Tennessee
Texas	3M & Am. Decal	40,000*	20,000	80,000*	10,000	30,000*	17,000	60,000*	5,000	American Decal (Adcolite)	red	prepared sign faces	regular usage		Texas
Utah	3M	16,575	1,650	24,577	975	6,580	5,325	20,240	600						Utah
Vermont	3M			(Total - 12,670 sq. ft. both years)						Sun Chemical (Sun-Lite)	s. white	150	experimental	Satisfactory performance	Vermont
Virginia	3M	113,700	44,850	199,875	9,000	85,275	33,638	149,907	149,907	American Decal (Adcolite)	s. white	2 rolls	experimental	Tests in progress	Virginia
Washington	3M	3,870	8,880	11,018	3,002	6,900	8,533	9,200	1,710						Washington
West Virginia	3M	50,000	5,000	50,000	1,000	65,000	10,000	65,000	1,000	American Decal (Adcolite)	orange	1 roll	experimental	Not yet evaluated	West Virginia
Wisconsin	3M	16,200	7,920	53,820	1,800	13,350	8,312	126,712	5,062	American Decal (Adcolite)	orange	3,150	experimental	Not satisfied. Material is non-uniform, poor quality control. Delivery is slow.	Wisconsin
Wyoming	3M	8,000	56,000	13,600	3,000	9,000	57,000	15,000	1,000						Wyoming
Total:		1,450,869	713,436	2,775,342	263,656	1,215,253	800,529	2,109,968	344,314						

(Note: Total - quantities identified by year and color only)

* Mostly American Decal & Mfg. Co. (Adcolite) material

State	Need for Materials Equal or Brighter Than High-Intensity Scotchite				High-Intensity Materials 1972 Purchases (sq. ft.)			Illuminate Overhead Signs			State
	YES	Using	NO	Using	S. White	Green	Other	YES	NO	Materials Used	
Alabama			X	Yes(limited)	1,575		2,850-yellow	X			Alabama
Alaska			X					X			Alaska
Arizona	X	Yes			interstate	interstate		X	few	high-intensity	Arizona
Arkansas	X	Yes			2,100		600-yellow	X			Arkansas
California			X	Yes(experimental)	limited			X			California
Colorado	X	Yes			1,500			X			Colorado
Connecticut			X	No				X			Connecticut
Delaware	X	Yes			(total-6,000 sq. ft.)			X			Delaware
Dist. of Columbia	X	Yes					stop signs, etc.	X			Dist. of Columbia
Florida	X	Yes(legend)			legend			X			Florida
Georgia	X	Yes			legend			X			Georgia
Hawaii			X	No				X			Hawaii
Idaho			X	No				X			Idaho
Illinois			X	Yes	legend		route shields	X			Illinois
Indiana	X	Yes			81,000	3,000		occasionally			Indiana
Iowa			X	Yes	10,000	20,000			X	high-intensity	Iowa
Kansas			X	No				X			Kansas
Kentucky	X	Yes			Yes	Yes(parkway signing)		X			Kentucky
Louisiana	X	Yes(overhead and shoulder signs)			Yes-since 1968	Yes		X			Louisiana
Maine			X	No				X	X	button legend	Maine
Maryland			X	Yes(limited)	1,200			X			Maryland
Massachusetts	X	Yes(experimental)						X	X	button legend	Massachusetts
Michigan			X	Yes(overhead)	9,200	7,240(1971)	150-yellow(1971)	X	few	high-intensity	Michigan
Minnesota			X	Yes(legend)	2,100			X	few	high-intensity	Minnesota
Mississippi								few	X	button legend	Mississippi
Missouri			X	No				X			Missouri
Montana			X	Yes(safety signing)				X			Montana
Nebraska	X	Yes			interstate	interstate		X			Nebraska
Nevada			X	Yes(legend)	1,500			X			Nevada
New Hampshire			X	No				X	few	button legend	New Hampshire
New Jersey			X	Yes(experimental)				X			New Jersey
New Mexico	X	Yes(legend)			100			X			New Mexico
New York	X	Yes(experimental)			limited	limited		few	X	button legend	New York
North Carolina			X	Yes(experimental)	limited	limited		X	X	high-intensity	North Carolina
North Dakota	X	Yes(interstate)			guide signs	effect signs		rural	X		North Dakota
Ohio			X	Yes(experimental)				X			Ohio
Oklahoma	X	No						X	some		Oklahoma
Oregon			X	Yes(limited)	illum. overhead signs	red		X			Oregon
Pennsylvania			X	No				X			Pennsylvania
Puerto Rico	X	No						X			Puerto Rico
Rhode Island	X	No						interchanges			Rhode Island
South Carolina			X	No				some	X	button legend	South Carolina
South Dakota	X	Yes(limited)			600	2,400			X	high-intensity	South Dakota
Tennessee	X	Yes			(total 95,000 sq. white and green)			some	X	high-intensity	Tennessee
Texas			X	No				X			Texas
Utah								X			Utah
Vermont			X	No					X	button legend	Vermont
Virginia	X	Yes(interstate)						X			Virginia
Washington	X	No						X			Washington
West Virginia	X	Yes						X			West Virginia
Wisconsin	X	Yes(experimental)			375		Red & orange	X	X	button legend	Wisconsin
Wyoming		Yes(legend)						X			Wyoming
Total:	24	Yes-21 No - 4	25	Yes-13 No - 11							

Responses to Question 8: Do you have any specific comments on specifications for reflective sheeting, durability of materials used, and manufacturers of reflective sheeting?

State	Comments
Alaska	Existing sheeting has performed well on existing installations.
Arizona	We would like to see a uniform policy of determining the color of reflective sheeting other than the present visual charts. We also believe that there is a need to fix a national policy on the minimum reflective brightness of reflective sheeting.
Connecticut	Generally, the Department is satisfied with the 3M reflective product. Although we feel certain improvements should be made in respect to life expectancy of the reflective sheeting, we plan to continue using this material until the superior product is marketed.
Idaho	Would like to see other manufacturers supply materials equal to 3M products.
Iowa	We like the encapsulated sheeting because of its reflectance when the temperature is below the dew point.
Maryland	Experience indicates that in certain cases the reflective sheetings are damaged by moisture. Need for the development of standards to measure resistance to moisture penetration is therefore emphasized.
Massachusetts	We are hoping that more competitive bidding will arise in the area of reflective sheeting.
Michigan	(a) Generally, specifications delineate quality control of materials currently being manufactured in lieu of needed performance in the field. (b) Durability is not tied down to any specific reflectivity at end of life.
Minnesota	To date we have accepted only 3M Company material. Only problem has been winter-time cold cracking which is peculiar to parts of Minnesota and Wisconsin due to temperature-humidity conditions. Some changes may be necessary to insure quality of competitive materials which may be appearing on the market.
Nebraska	Use of reflective sheeting generally satisfactory. Some problems have occurred with material and fabrication techniques. It is believed that most of these problems have or can be resolved.
New York	Would like to see more acceptable products.
Vermont	The durability of the reflective sheeting we are using is very good. We feel that the reflectivity for background use is more than ample. We do not use reflective sheeting for legends.
Virginia	It is possible that the ARBA-AASHO Joint Committee, Task Force No. 7 which is working on proposed reflective sheeting (specification), will come up with a better specification than Federal Specification L-S-300 A which is used in part and referenced to in manufacturers' specifications.
Wyoming	We have only dealt with 3M Company and had very good luck.

APPENDIX

Questionnaire on

Reflective Sheeting for Highway Signs



QUESTIONNAIRE
KENTUCKY DEPARTMENT OF HIGHWAYS
REFLECTIVE SHEETING FOR HIGHWAY SIGNS

1. (a) Do you use specifications (reflectivity, durability, color, etc.) in purchasing reflective sheeting? Yes _____ No _____.

If you purchase by specifications, please attach a copy of your specifications.

- (b) If yes in (a) above, please indicate the source of your specifications:

_____ (1) Established on the basis of agency's experience and testing of available materials.

_____ (2) Manufacturers specifications

Which specification(s):

_____ (3) Federal Specification L-S-300 A or portions thereof. Cite which parts:

_____ (4) Combination of items (1) _____, (2) _____, (3) _____.

- (c) If yes in (a) above, are you planning to update or to amend your specifications in the near future? Yes _____ No _____.

Which features (reflectivity, durability, etc.)?:

- (d) If no in (a) above, are you in process of developing or establishing, or considering so, specification requirements? Yes _____ No _____.

If yes, by what means?

Item b-1 _____

Item b-2 _____

Item b-3 _____

Combination of items (b-1) _____, (b-2) _____, (b-3) _____.

2. Do you award contracts for reflective sheeting from sealed bids?
Yes _____ No _____

If yes, please provide a recent invitation for bids on reflective sheeting.

3. Do you require the materials to prequalify before award of purchase contract? Yes _____ No _____.

If yes, by what means do you determine the qualifications of the materials?

_____ (a) In-house testing and evaluation

_____ (b) Test reports from independent testing laboratories

_____ (c) Manufacturer's certification as to conformity of the material to applicable specifications.

_____ (d) Manufacturer's certification of test results from an independent laboratory.

4. Do you conduct tests on samples of reflective sheeting from individual shipments of materials? Yes _____ No _____.

If yes, what tests do you perform?

_____ (a) Reflectivity

_____ (b) Color, Visual _____ or instrumental _____ tests
(such as with a Color Difference Meter)

_____ (c) Others, specify:

5. Please indicate the manufacturer and quantities of each color materials purchased in Fiscal Years 1971 and 1972.

(a) Principal manufacturer of purchased materials:

Approximate Quantities (in sq. ft.)

<u>Color</u>	<u>FY 1971</u>	<u>FY 1972</u>
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Enclosed Lens Type Materials

Yellow
Green
Silver White
Blue

Other Sheeting Materials, (Specify Type)

Yellow
Green
Silver White
Blue

(b) Manufacturer of lesser quantities purchased:

Approximate Quantities

<u>Color</u>	<u>FY 1971</u>	<u>FY 1972</u>
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Yellow
Green
Silver White
Blue

(c). Other sources of recently purchased materials

(1) Manufacturer:

(2) Quantities:

(3) Types of sheeting and color:

(4) Reason for purchase (experimental, etc.):

(5) Are you satisfied with the characteristics and performance of the material? *

(6) Additional information, if available.



6. (a) Do you feel that materials equal to or brighter than those cited below are needed or desired to improve sign legibility under low-beam headlight illumination conditions? Yes _____ No _____.

<u>Color</u>	<u>Divergence Angle</u>	<u>Incidence Angle</u>	<u>Reflectivity in candlepower/foot-candle/sq. ft.</u>
Silver White	0.5°	4°	65
Silver White	0.2°	4°	180
Green	0.5°	4°	10
Green	0.2°	4°	30

- (b) Are you using any materials as cited above in (a)? Yes _____ No _____

If yes, what type of material are you using?

State the criterion under which such materials are being used:

7. Do you illuminate overhead signs? Yes _____ No _____

If no, what type of materials, (background and legend) are you primarily using?

8. Do you have any specific comments on specifications for reflective sheeting, durability of materials used, and manufacturers of reflective sheeting?

9. Would you be interested in a summary report on this questionnaire?
Yes _____ No _____

State Responding: _____ Date: _____

Name: _____

Title: _____