Florida Department of Transportation

CHARLIE CRIST
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

STEPHANIE KOPELOUSOS
SECRETARY

January 23, 2008

Dr. Leslie McCarthy, PhD, P.E.
Program Operations Engineer
Federal Highway Administration
545 John Knox Road, Suite 200
Tallahassee, Florida 32303

Re: Office of Design, Specifications
Section 994
Proposed Specification: 9940000 Retroreflective and Nonreflective Sheeting for Traffic Control Devices

Dear Dr. McCarthy:

We are submitting, for your approval, two copies of a proposed Supplemental Specification for Retroreflective and Nonreflective Sheeting for Traffic Control Devices.

This change was proposed by Chester Henson of the State Roadway Design Office to update the ASTM D4956 reference and various requirements within the specification.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via Email to SP965DB or duane.brautigam@dot.state.fl.us.

If you have any questions relating to this specification change, please call Duane F. Brautigam, State Specifications Engineer at 414-4110.

Sincerely,

Signature on file

Duane F. Brautigam, P.E.
State Specifications Engineer

DFB/dm
Attachment
cc: Gregory Jones, General Counsel
Florida Transportation Builders' Assoc.
State Construction Engineer

RETROREFLECTIVE AND NONREFLECTIVE SIGN SHEETING FOR TRAFFIC CONTROL DEVICES
(REV ~~11-13~~*20-07* ~~07~~ *01-15-08*)

SECTION 994 (Pages 913-917) is deleted and the following substituted:

SECTION 994
RETROREFLECTIVE AND NONREFLECTIVE ~~SIGN~~ SHEETING *FOR TRAFFIC CONTROL DEVICES*

994-1 Description.

994-1.1 General: This Section specifies the requirements for retroreflective and nonreflective sheeting materials, transparent and opaque process inks for retroreflective sheeting materials~~,~~ and film overlays for traffic control devices. The sheeting materials used shall be one of the products included on the Qualified Products List (QPL), as specified in 6-1.

994-1.2 Classification: Retroreflective sheeting materials~~~~ *Types III, IV, V, and VI* shall be classified in accordance with ASTM D4956. In addition, a *special classification,* Type VII *(Special)* ~~reflective sheeting~~ is added for ~~a~~ super high *intensity* retroreflective sheeting ~~with high performance angularity properties~~. *This special classification shall include materials classified as Type VII and above~~higher~~ in accordance with ASTM D4956. A special classification for Type VI fluorescent pink is also added.*

994-2 Materials.

Retroreflective ~~sign~~ sheeting, screen processing inks~~,~~ and film overlay materials used for any of the applications described herein shall be one of the products included on the QPL, as specified in 6-1. The retroreflective sheeting shall meet the requirements of Types III, IV, V, VI in ASTM D4956 or *Type* VII *(Special) and fluorescent pink* listed below in accordance with their approved usage. Samples shall be taken in accordance with the Department's Sampling, Testing and Reporting Guide Schedule and on a random basis at the discretion of the Engineer.

994-3 *Performance*~~Physical~~ Requirements.

994-3.1 Testing: The retroreflective sheeting shall be tested in accordance with ASTM D4956 and the Florida Test Method for retroreflective and nonreflective sheeting, FM 5-571. For retroreflectivity, the sheeting materials shall meet the minimum requirements as stated for 0.2 degree and 0.5 degree observation angles in ASTM D4956. Evaluation of test samples shall be field tested in accordance with FM 5-571 for each color.

994-3.2 Retroreflective Intensity: The retroreflective sheeting *shall meet the minimum initial requirements as stated for 0.2 degree and 0.5 degree observation angles in ASTM D4956.*~~shall meet the requirements in ASTM D4956 for the overall performance of each property listed. In addition to minimum coefficients of retroreflection listed in ASTM D4956, fluorescent yellow-green sheeting shall have a minimum coefficient of retroreflection of 200 at 0.2 /-4, 100 at 0.2 /30, 80 at 0.5 /-4 and~~

~~45 at 0.5 /30 (observation angle/entrance angle) for ASTM D4956 Tables 4, 6, 7 and 8.~~ *Type VI fluorescent pink sheeting and* Type VII *(Special) sheeting shall meet the minimum retroreflectivity* requirements ~~are~~ listed *below.* ~~in Table 13 below~~. ~~*Type V fluorescent pink sheeting shall meet the minimum retroreflectivity requirements also listed below.*~~

994-3.3 Color: The retroreflective and nonreflective sheeting or film shall *conform to both the daytime and nighttime color requirements of ASTM D4956,* ~~have the same daytime and nighttime color when viewed by reflective light regardless of type classification. The diffused color of the retroreflective sheeting, through instrumental color testing, shall conform to the requirements of ASTM D4956.~~ In addition to ASTM D4956 ~~Table 13~~, the ~~fluorescent orange, fluorescent yellow-green and~~ fluorescent pink *initial* color~~s~~ shall meet the following x, y chromaticity coordinates:

~~Fluorescent~~	~~1~~	~~2~~	~~3~~	~~4~~
~~Yellow/Green~~				
~~X~~	~~.387~~	~~.368~~	~~.421~~	~~.460~~
~~Y~~	~~.610~~	~~.539~~	~~.486~~	~~.540~~
~~Orange~~				
~~X~~	~~.583~~	~~.535~~	~~.595~~	~~.645~~
~~Y~~	~~.416~~	~~.400~~	~~.351~~	~~.355~~

Fluorescent Pink	1	2	3	4
x~~X~~	.450	.590	.644	.536
y~~Y~~	.270	.350	.290	.230

The daytime luminance *factor shall meet ASTM D4596 except* for ~~fluorescent orange, fluorescent yellow-green and~~ fluorescent pink sheeting *which* shall have a *minimum* luminance factor of 25 ~~minimum, 60 minimum and 25 minimum respectively, in addition to ASTM D4956 Table 9~~.

994-3.3.1 Accelerated Outdoor Test: The retroreflective and nonreflective materials shall meet the ASTM D4956 *Accelerated Outdoor Table* weathering requirements for performance *except Type VI fluorescent pink and fluorescent yellow*. ~~Retroreflective materials shall meet the minimum coefficient of retroreflection as listed in Table 11 in accordance with FM 5-571~~.

994-3.4 Adhesive Backing:

~~**994-3.4.1 General:**~~ The adhesive backing of the retroreflective and nonreflective sheeting or film shall be either Class 1, Class 2 or Class 5 per ASTM D4956~~, Section 4.3~~. The retroreflective and nonreflective sheeting or film, after application, shall tightly adhere to the application surface and show no discoloration, cracking, crazing, blistering or dimensional change.

~~**994-3.4.2 Protective Liner:** The protective liner over the adhesive backing shall be removable from the adhesive backing by peeling without soaking in water or other solvents and without breaking, tearing or removing any adhesive from the adhesive backing in accordance with ASTM D4956, Section 7.10.~~

~~**994-3.5 Film:** The exterior film of the sheeting shall be a flexible, smooth-surfaced, moisture resisting material and shall have sufficient strength and flexibility to be easily handled, cut to shape, processed and applied without stretching, tearing, or other damage. In addition, retroreflective sheeting shall have a transparent exterior film.~~

~~**994-3.6 Tensile Strength:** The retroreflective and nonreflective sheeting or film shall have a minimum tensile strength of five pounds-force so that the sheeting can be handled, processed and applied without damage to sheeting. The tensile strength shall be tested in accordance with ASTM D882.~~

994-*3.5*~~3.7~~ Physical Properties: The retroreflective and nonreflective sheeting or film material shall meet the ASTM D4956 minimum requirements for *colorfastness, shrinkage, flexibility, liner removal, adhesion, impact resistance and* specular gloss~~, shrinkage and flexibility~~.

~~**994-3.8 Workability:** The retroreflective and nonreflective sheeting or film shall permit preapplication handling, positioning, cutting by hand or die machine and oven drying. In addition, retroreflective sheeting shall permit color processing.~~

~~**994-3.9 Chemical Resistance:** The retroreflective and nonreflective sheeting or film shall be chemically resistant so as to permit cleaning with naphtha and mineral spirits, turpentine, mild soaps, detergents and alcohol.~~

994-*3.6*~~3.10~~ Color Processibility: The retroreflective sheeting shall permit color processing with compatible transparent and opaque process inks as approved by the sheeting manufacturer and listed on the QPL.

~~Table 13~~
Type VII *(Special)* Sheeting

Minimum Coefficient of Retroreflection
(cd/*f*~~F~~oot-candle·ft^2)*(cd/fc*~~*lx*~~·*ft*~~*m*~~^{2}*)*

Observation/Entrance Angle (degree)	White	Yellow	Red	Orange	Blue	Green	Brown	Fluorescent Orange	Fluorescent Yellow	Fluorsecent Yellow/Green
0.2/-4	380	304	95	250	19	38	19	180	220	360
0.5/-4	250	195	55	100	12	25	8	60	145	235
0.2/30	220	176	48	110	11	22	9	85	125	205
0.5/30	135	105	30	50	7	14	3	33	75	125

~~Note: Tables 1-12 are found in ASTM D4956~~

Type VI Sheeting

Minimum Coefficient of Retroreflection
(cd/*f*~~F~~oot-candle·ft^2)*(cd/fc*~~*lx*~~·*ft*~~*m*~~^{2}*)*

Observation/Entrance Angle (degree)	Fluorescent Pink
0.2/-4	160
0.5/-4	100
0.2/30	100
0.5/30	40

994-4 Direct and Reverse Screen Processing.

994-4.1 General: The transparent and opaque process inks furnished for direct and reverse screen processing shall be of a type and quality formulated for retroreflective

sheeting materials as listed on the QPL and applied in accordance with the manufacturer's instruction. Screen processing in accordance with the techniques and procedures recommended by the manufacturer shall produce a uniform legend of continuous stroke width of either transparent or opaque ink, with sharply defined edges and without blemishes on the sign background that will affect the intended sign use. The process inks shall be one of the products listed on the QPL.

~~**994-4.2 Retroreflective Intensity:** Finished signs produced by the reverse screening process using transparent ink with retroreflective sheeting shall meet the minimums as specified in 994-3.2.~~

~~994-~~*4.2*~~**4.3** **Color:** The diffused~~ daytime color of the finished transparent process inks shall conform to the requirements as specified in 994-3.3.

994-5 In-Service Minimum Requirements.

The retroreflective sheeting and screen processed retroreflective sheeting shall have the minimum coefficient of retroreflection as shown in ASTM D4956, *Outdoor Weathering Photometric Requirements for All Climates except Type VI fluorescent pink and fluorescent yellow.*~~Table 11 for minimum coefficient of retroreflection~~ *In addition, Type VII (Special) classified sheeting materials shall have a minimum coefficient of retroreflection of 80% of the values listed in the above table. Only the*~~using an~~ observation angle of 0.2 degrees and an entrance angle of -4 degrees *shall be used in measuring in-service minimums. The in-service life for opaque overlay films, black processing inks and opaque lettering shall equal the life of the reflective sheeting to which it is applied.*~~In addition, Type VII sheeting materials shall have a minimum coefficient of retroreflection of 80% of the values listed in Table 13. The satisfactory predicted performance life for overlay films, black process inks and lettering shall equal the number of predicted performance life years of the retroreflective sheeting to which it is applied. Type III, IV, V and VII sheeting materials shall have a minimum performance life of at least ten years for each color except orange and fluorescent orange which shall have a minimum performance of at least three years and all other fluorescent colors which shall have a minimum performance of at least seven years. Performance life shall be based on the performance requirements of ASTM D4956 and FM 5-571.~~

994-6 Packaging and Labeling.

Shipment shall be made in containers which are acceptable to common carriers and packaged in such a manner as to ensure delivery is in perfect condition. Each package shall be clearly marked as to the name of the manufacturer, *series*~~type~~, color, quantity enclosed and date of manufacture. ~~Show the type designation of the sheeting in accordance with ASTM D4956 and this Specification.~~

994-7 Certification.

For permanently installed signs, the Contractor shall be required to furnish to the Engineer one ~~certified test report~~ *material*~~*notarized*~~ *certification* from the sheeting manufacturer documenting that the retroreflective sheeting meets the requirements of this Section.~~ The certified test report shall include test results for retroreflectivity, color, adhesive backing properties, film description, tensile strength, specular gloss, shrinkage, flexibility and chemical resistivity. The certified test report shall affirm the product meets all the requirements specified. If test results indicate significant inconsistencies in~~

~~material properties, new qualification tests and/or comparison with original infrared spectroscopic values may be required.~~ Each certification shall cover only one type of retroreflective or non reflective sheeting or film. The certification shall meet the requirements in Section 6. ~~Due to the wide range of applications of the products within some types, the certification shall additionally state that this product is recommended for use on this specified project.~~

~~———~~Certification shall not be required for signs *and devices* used in the work zone.

994-8 Qualified Products List.

994-8.1 General: All reflective and nonreflective sheeting materials and process inks shall be one of the products listed on the QPL. Products may only be used for applications recommended by the manufacturer. A notation of the sheeting materials approved for the inks may be placed on the QPL.

994-8.2 Other Requirements: Manufacturers seeking approval of sheeting material products shall submit an application, Material Safety Data Sheet (MSDS), and certification. Non-sheeting materials may be submitted under this Section with reference to specific equivalency of performance requirements of overall end product. Final acceptance will be based on tests and verification in accordance with this Specification, FM 5-571 and 6-1.

994-9 Samples.

Field samples will be obtained in accordance with the Department's Sampling, Testing and Reporting Guide Schedule.

RETROREFLECTIVE AND NONREFLECTIVE SIGN SHEETING FOR TRAFFIC CONTROL DEVICES
(REV 01-15-08)

SECTION 994 (Pages 913-917) is deleted and the following substituted:

SECTION 994
RETROREFLECTIVE AND NONREFLECTIVE SHEETING FOR TRAFFIC CONTROL DEVICES

994-1 Description.

994-1.1 General: This Section specifies the requirements for retroreflective and nonreflective sheeting materials, transparent and opaque process inks for retroreflective sheeting materials and film overlays for traffic control devices. The sheeting materials used shall be one of the products included on the Qualified Products List (QPL), as specified in 6-1.

994-1.2 Classification: Retroreflective sheeting material Types III, IV, V, and VI shall be classified in accordance with ASTM D4956. In addition, a special classification, Type VII (Special) is added for super high intensity retroreflective sheeting. This special classification shall include materials classified as Type VII and above in accordance with ASTM D4956. A special classification for Type VI fluorescent pink is also added.

994-2 Materials.

Retroreflective sheeting, screen processing inks and film overlay materials used for any of the applications described herein shall be one of the products included on the QPL, as specified in 6-1. The retroreflective sheeting shall meet the requirements of Types III, IV, V, VI in ASTM D4956 or Type VII (Special) and fluorescent pink listed below in accordance with their approved usage. Samples shall be taken in accordance with the Department's Sampling, Testing and Reporting Guide Schedule and on a random basis at the discretion of the Engineer.

994-3 Performance Requirements.

994-3.1 Testing: The retroreflective sheeting shall be tested in accordance with ASTM D4956 and the Florida Test Method for retroreflective and nonreflective sheeting, FM 5-571. For retroreflectivity, the sheeting materials shall meet the minimum requirements as stated for 0.2 degree and 0.5 degree observation angles in ASTM D4956. Evaluation of test samples shall be field tested in accordance with FM 5-571 for each color.

994-3.2 Retroreflective Intensity: The retroreflective sheeting shall meet the minimum initial requirements as stated for 0.2 degree and 0.5 degree observation angles in ASTM D4956. Type VI fluorescent pink sheeting and Type VII (Special) sheeting shall meet the minimum retroreflectivity requirements listed below..

994-3.3 Color: The retroreflective and nonreflective sheeting or film shall conform to both the daytime and nighttime color requirements of ASTM D4956, In

addition to ASTM D4956, the fluorescent pink initial color shall meet the following x, y chromaticity coordinates:

Fluorescent Pink	1	2	3	4
x	.450	.590	.644	.536
y	.270	.350	.290	.230

The daytime luminance factor shall meet ASTM D4596 except for fluorescent pink sheeting which shall have a minimum luminance factor of 25.

994-3.3.1 Accelerated Outdoor Test: The retroreflective and nonreflective materials shall meet the ASTM D4956 Accelerated Outdoor Table weathering requirements for performance except Type VI fluorescent pink and fluorescent yellow..

994-3.4 Adhesive Backing: The adhesive backing of the retroreflective and nonreflective sheeting or film shall be either Class 1, Class 2 or Class 5 per ASTM D4956. The retroreflective and nonreflective sheeting or film, after application, shall tightly adhere to the application surface and show no discoloration, cracking, crazing, blistering or dimensional change.

994-3.5 Physical Properties: The retroreflective and nonreflective sheeting or film material shall meet the ASTM D4956 minimum requirements for colorfastness, shrinkage, flexibility, liner removal, adhesion, impact resistance and specular gloss.

994-3.6 Color Processibility: The retroreflective sheeting shall permit color processing with compatible transparent and opaque process inks as approved by the sheeting manufacturer and listed on the QPL.

Type VII (Special) Sheeting										
Minimum Coefficient of Retroreflection (cd/foot-candle·ft^2)(cd/fc·ft^2)										
Observation/Entrance Angle (degree)	White	Yellow	Red	Orange	Blue	Green	Brown	Fluorescent Orange	Fluorescent Yellow	Fluorsecent Yellow/Green
0.2/-4	380	304	95	250	19	38	19	180	220	360
0.5/-4	250	195	55	100	12	25	8	60	145	235
0.2/30	220	176	48	110	11	22	9	85	125	205
0.5/30	135	105	30	50	7	14	3	33	75	125

Type VI Sheeting	
Minimum Coefficient of Retroreflection (cd/foot-candle·ft^2)(cd/fc·ft^2)	
Observation/Entrance Angle	Fluorescent Pink
(degree)	
0.2/-4	160
0.5/-4	100
0.2/30	100
0.5/30	40

994-4 Direct and Reverse Screen Processing.

994-4.1 General: The transparent and opaque process inks furnished for direct and reverse screen processing shall be of a type and quality formulated for retroreflective sheeting materials as listed on the QPL and applied in accordance with the manufacturer's instruction. Screen processing in accordance with the techniques and procedures recommended by the manufacturer shall produce a uniform legend of continuous stroke width of either transparent or opaque ink, with sharply defined edges and without blemishes on the sign background that will affect the intended sign use. The process inks shall be one of the products listed on the QPL.

994-4.2 Color: The daytime color of the finished transparent process inks shall conform to the requirements as specified in 994-3.3.

994-5 In-Service Minimum Requirements.

The retroreflective sheeting and screen processed retroreflective sheeting shall have the minimum coefficient of retroreflection as shown in ASTM D4956, Outdoor Weathering Photometric Requirements for All Climates except Type VI fluorescent pink and fluorescent yellow. In addition, Type VII (Special) classified sheeting materials shall have a minimum coefficient of retroreflection of 80% of the values listed in the above table. Only the observation angle of 0.2 degrees and an entrance angle of -4 degrees shall be used in measuring in-service minimums. The in-service life for opaque overlay films, black processing inks and opaque lettering shall equal the life of the reflective sheeting to which it is applied.

994-6 Packaging and Labeling.

Shipment shall be made in containers which are acceptable to common carriers and packaged in such a manner as to ensure delivery is in perfect condition. Each package shall be clearly marked as to the name of the manufacturer, series, color, quantity enclosed and date of manufacture.

994-7 Certification.

For permanently installed signs, the Contractor shall be required to furnish to the Engineer one material certification from the sheeting manufacturer documenting that the retroreflective sheeting meets the requirements of this Section. Each certification shall cover only one type of retroreflective or non reflective sheeting or film. The certification shall meet the requirements in Section 6.
Certification shall not be required for signs and devices used in the work zone.

994-8 Qualified Products List.

994-8.1 General: All reflective and nonreflective sheeting materials and process inks shall be one of the products listed on the QPL. Products may only be used for applications recommended by the manufacturer. A notation of the sheeting materials approved for the inks may be placed on the QPL.

994-8.2 Other Requirements: Manufacturers seeking approval of sheeting material products shall submit an application, Material Safety Data Sheet (MSDS), and certification. Non-sheeting materials may be submitted under this Section with reference to specific equivalency of performance requirements of overall end product. Final

acceptance will be based on tests and verification in accordance with this Specification, FM 5-571 and 6-1.

994-9 Samples.

Field samples will be obtained in accordance with the Department's Sampling, Testing and Reporting Guide Schedule.