

# OFFICE MEMORANDUM

DATE: March 28, 1979

TO: K. A. Allemeier  
Engineer of Testing and Research

FROM: M. H. Janson

SUBJECT: NFS Industries Delineators  
Research Project 78 NM-560, Research Report No. R-1111

This is in response to D. E. Orne's October 12, 1978 request to test the subject delineators and to report a laboratory evaluation of a second submittal of the delineators.

Unfavorable results of tests from the first submittal were reported on October 30, 1978.

Representatives of NFS Industries claimed that the first samples were a "mock-up" and, therefore, on December 15, 1978, submitted claimed production samples. NFS representatives noted, however, that the plastic in the crystal delineators was contaminated which resulted in a slight cloudiness. Photometric data from an independent laboratory was submitted along with the samples. Four Model 160 units, as shown in Figure 1, were submitted, two crystal and two yellow.

Photometric tests along with color tests, sealing tests, heat or warping tests, and a material identification were conducted. Results of the photometric tests compared favorably with the independent laboratory test results and other results show that the manufacturer can produce satisfactory delineators if quality control is improved.

Color of the yellow delineators conforms with specified requirements as shown in Figure 2. The figure shows an outline of the specified SAE color space and the chromaticity coordinates obtained from measurements on a 0.25-in. thick disc molded from pieces of the delineator. Cloudiness of the crystal delineators as suspected by NFS was evident. A 0.25-in. thick disc had an 85.4 percent transmission factor. Clear acrylics can be expected to have a 90 to 92 percent transmission factor.

The seal between the front face and the supporting back face was considered satisfactory. The delineators showed no evidence of water intake after being submerged in water in a pressurized container at 2.5 psi for 15 minutes.

Results from a heat test which subjected the delineators to a 125 F temperature for four hours showed a 5 to 20 percent loss in the photometric performance of the delineators.

The delineator face material was identified as an acrylic plastic and the support backing was identified as ABS plastic.

Considering intended use, the NFS delineators reasonably conform with MDOT specific luminance requirements for center mount delineators. From an approximate 400 ft driver sight condition and beyond, NFS and center mount delineators provide approximately equivalent reflective intensity performance in an entrance angle range of  $\pm 25$  degrees. However, under these conditions the NFS delineators exceed the performance of center mount delineators at 30-degree entrance angles and maintain a useful retroreflective range to  $\pm 50$  degrees. At sight distances less than 300 ft the NFS delineators perform approximately equal to a Type 3 (3M High Intensity) reflective sheeting (10 sq in.) delineator. The above comparisons are based on a photometric 0 degree entrance angle that is normal with respect to the face of the delineator and a mounting orientation angle of 90 degrees or normal to the driver's line of sight. Entrance angles and orientation angle geometries are shown in Figure 3.

Required performance at entrance angles greater than  $\pm 20$  degrees is usually limited to sight distances less than 400 ft and to horizontal curves, ramps, and reduced speed areas. Delineation in such areas might be improved by installing NFS delineators.

The NFS delineators as submitted were fitted with a support backing which permitted adhesive fastening to a vertical surface—such as a concrete barrier—at either a 90 degree or 60 degree angle to produce 0 degree or 30 degree photometric entrance angle geometries, respectively. Tables 1 and 2 show specific luminance values for each of these mounting geometries. Values are also shown for center mount delineators and reflective sheeting. The values can be used for delineator intensity comparisons for sight distances of at least 400 ft.

NOTE: It must be understood that the specific luminance values are similar to efficiency values and can only be used for comparing various types of delineators. The values at the various orientation or entrance angles of a given delineator cannot be compared to show field performance. The values are not equivalent to brightness as seen by a driver. For example, the specific luminance value at the 10 degree entrance angle is  $2/3$  the 0 degree value but in the field, headlight illumination available at 10 degrees is only about 10 percent of the 0 degree illumination, and, therefore, a comparison for field performance would show that at 10 degrees the brightness is about  $1/15$  the brightness at 0 degrees. Comparisons of data under similar viewing and lighting conditions can show, for example, that at 40 degrees the NFS delineators would appear brighter than a center mount delineator, but human eye response would render the comparison somewhat less than the approximately 10 times difference shown by the specific luminance values.

NFS delineators mounted on a barrier wall in the 90 degree mounting geometry would protrude about 4 in. from the barrier and about 3 in. in the 60 degree mounting geometry. Since the protruding delineator appears to be highly susceptible to impact damage, a relatively short service life can be expected. If protrusion from the wall is not an important consideration, then the use of either two center mount delineators or two pieces of Type 3 sheeting mounted as shown in Figure 4 can be recommended for barrier wall delineation. The alternative is suggested on the basis of center mount delineator or sheeting delineator performance as summarized in Tables 1 and 2, and on the basis that delineators installed as shown in the figure would cost about the same as one NFS delineator.

It is recommended that NFS delineators be evaluated under field conditions especially in ramp and horizontal curve areas. If available, red units for wrong-way delineation and green units for obstacle identification should be considered. Experimental barrier wall installations can be recommended with the reservation that a short service life is expected. Optical performance characteristics for limited viewing distance delineators are recommended as shown in Table 3.

TABLE 3  
OPTICAL PERFORMANCE OF LIMITED  
VIEWING DISTANCE DELINEATORS\*

Color	Specific Luminance, Candlepower Per Footcandle Per Unit At 0.2 Degree Divergence Angle		
	Entrance Angle, degrees		
	0	+20	+60
Crystal	25	25	25
Yellow	15	15	15

\* Oriented per manufacturer's recommendations.

TESTING AND RESEARCH DIVISION

*Mervin H. Jensen*  
Supervisor - Spectrochemistry and  
Photometry Unit

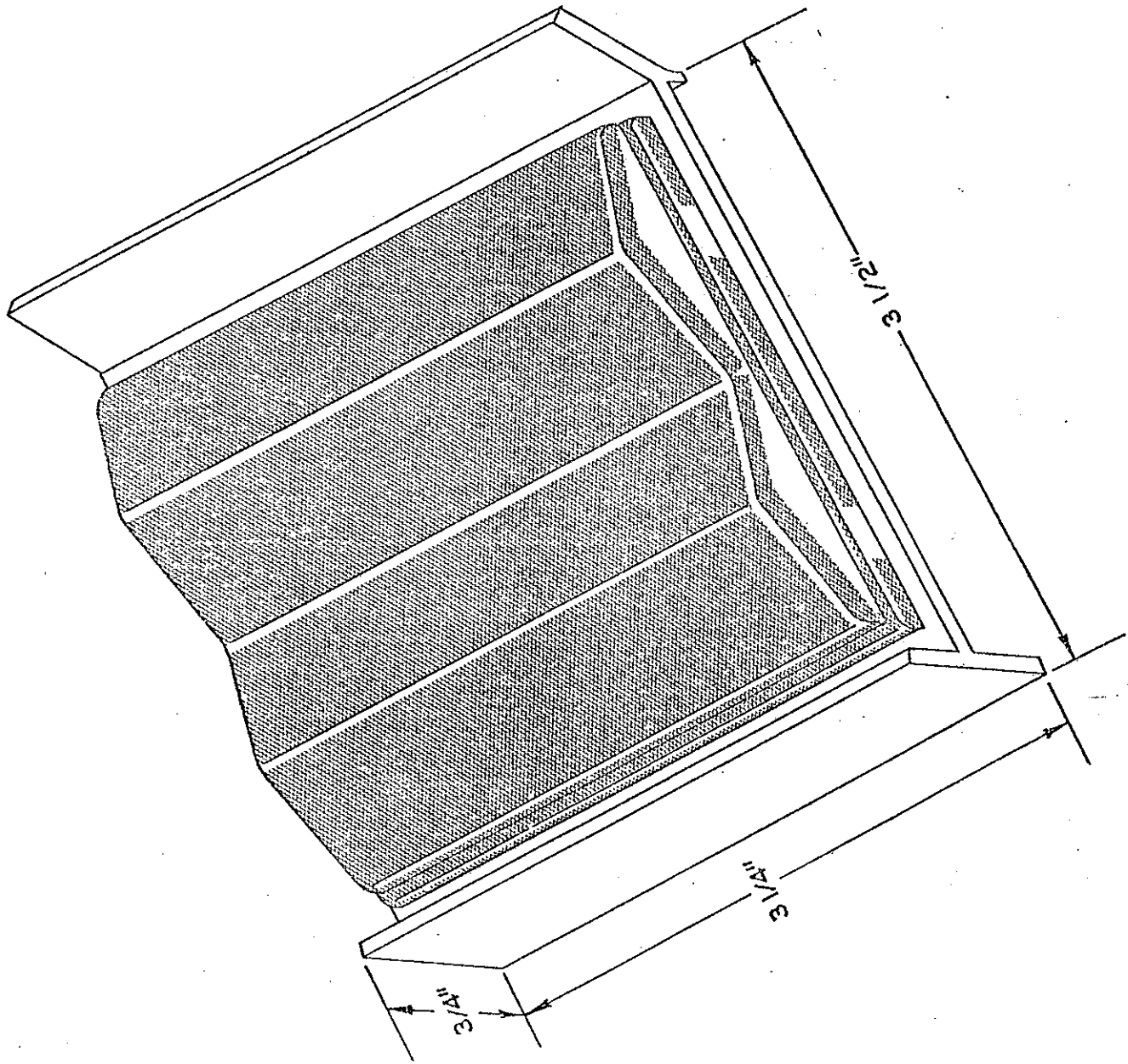


Figure 1. NFS Industries Inc. delineator Model 160.

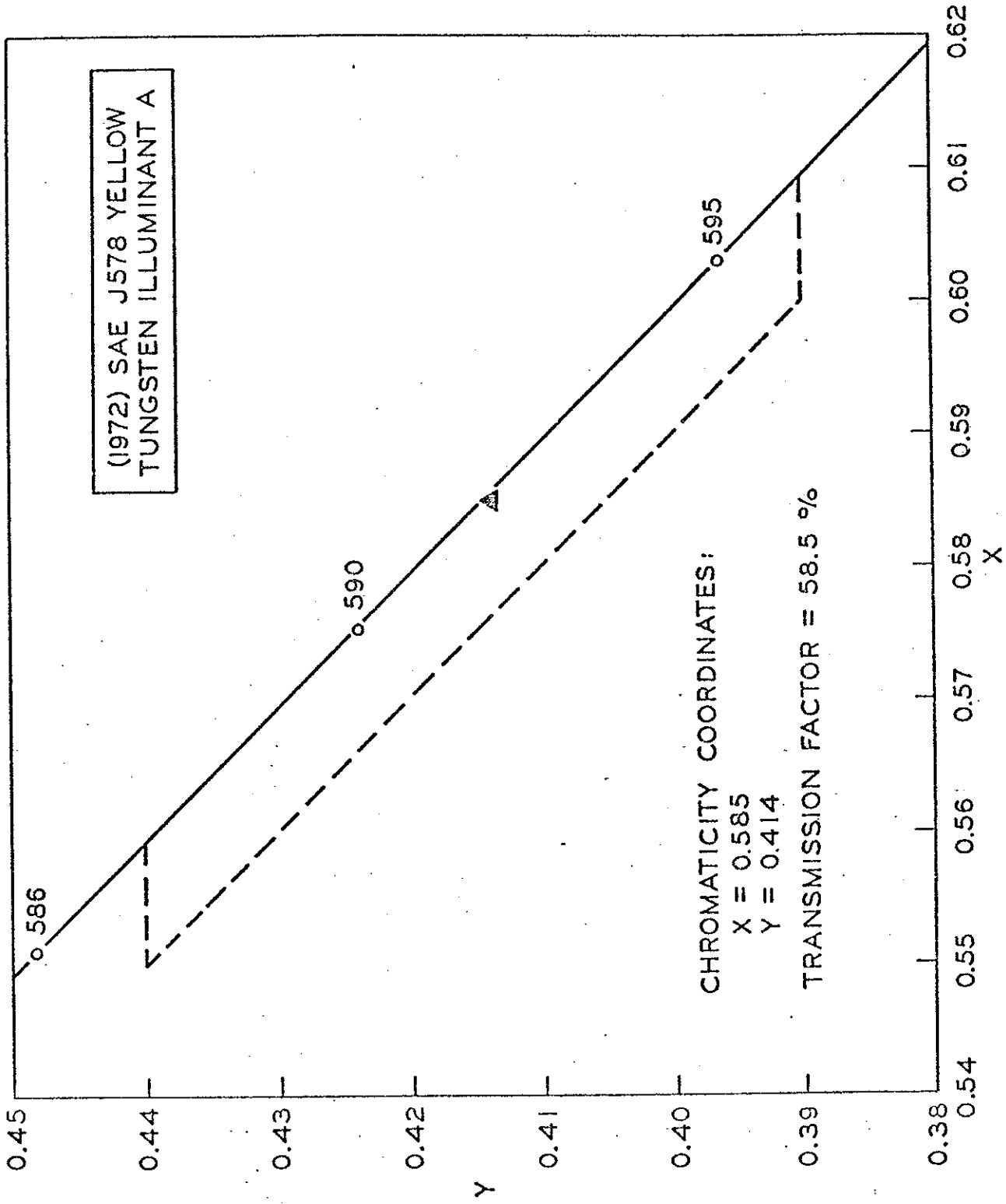


Figure 2. NFS Industries-delineator, yellow, Laboratory No. 78 RD-290B.

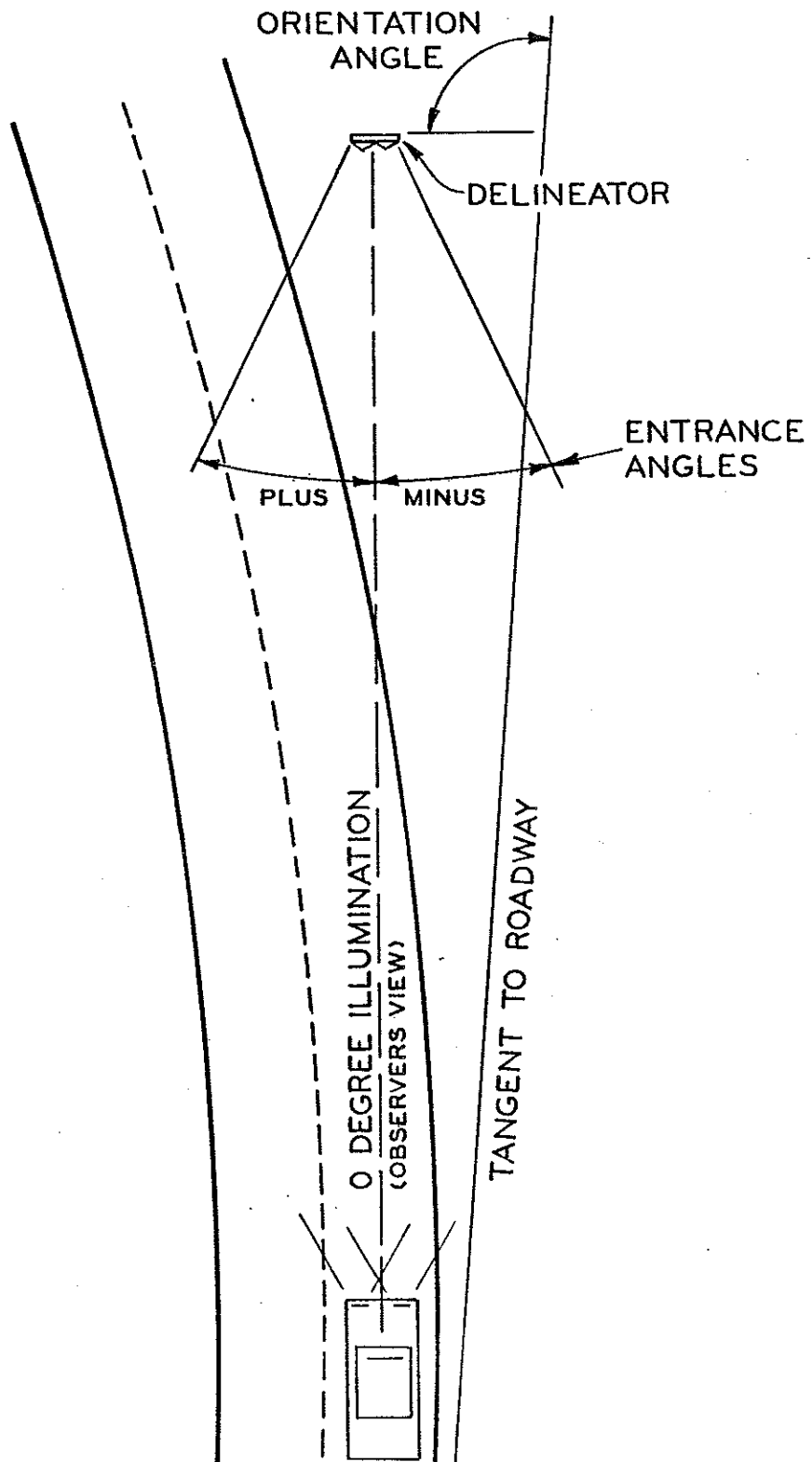


Figure 3. Delineator entrance angle and orientation angle geometries.

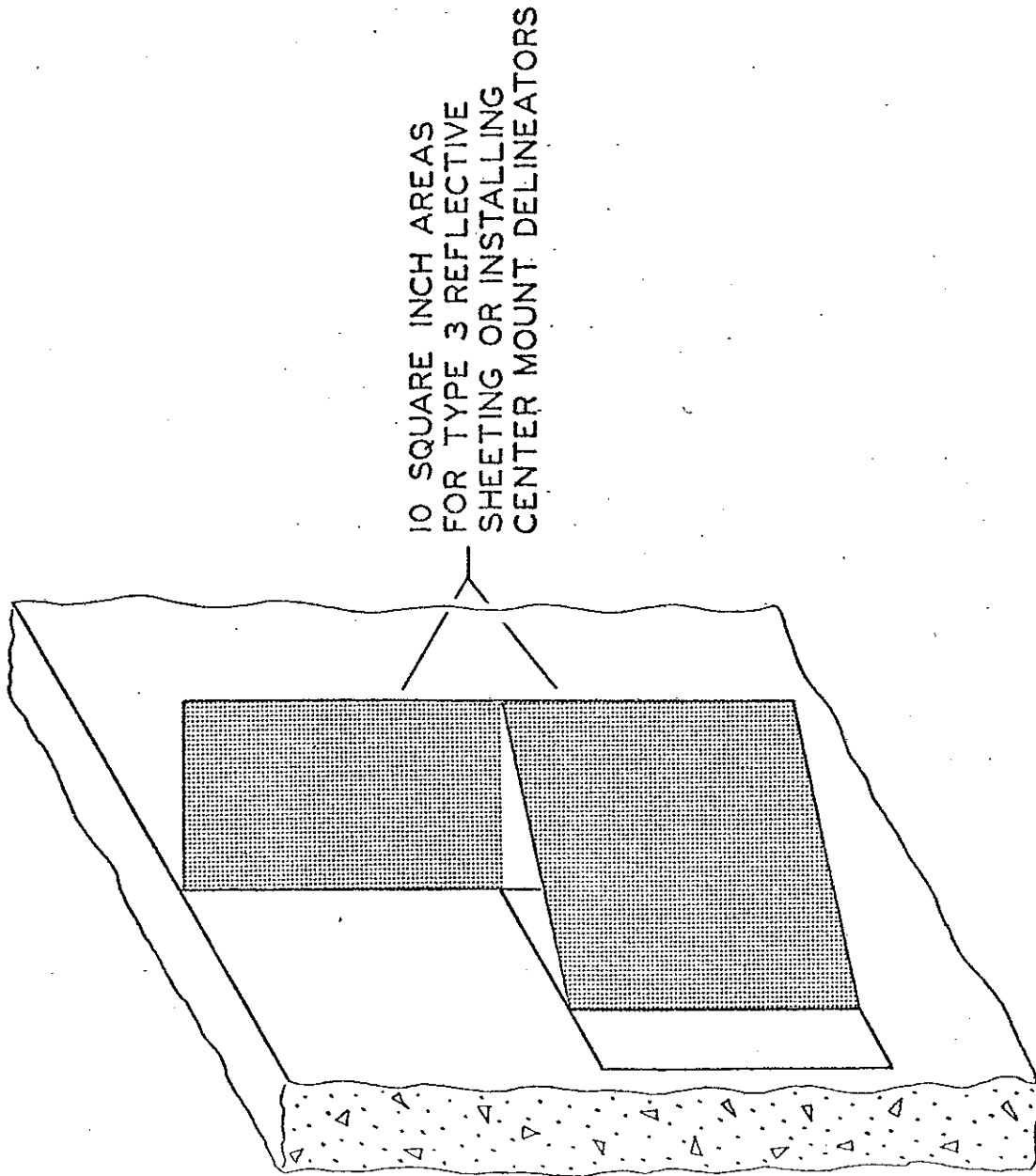


Figure 4. Proposed delineator assembly for concrete barrier.





Table 2

## Specific Luminance of NFS Model 160 Yellow Delineators

Delineator Identification and Mounting Orientation	Specific Luminance ep/ftc/unit at 0.2 Deg Divergence																					
	Entrance Angles																					
	70	60	50	40	30	25	20	15	10	5	0	5	10	15	20	25	30	40	50	60	70	
90 Degree Orientation NFS, Laboratory No. 78 RD-290A	0.2	2.5	9.5	19.0	29.0	32.3	36.4	38.5	38.9	38.5	36.4	32.3	29.0	23.7	19.0	14.1	9.5	5.8	2.5	0.2	---	---
NFS, Laboratory No. 78 RD-290B	0.2	1.9	7.3	14.5	23.7	28.4	33.3	39.0	41.5	43.8	45.5	46.2	41.9	36.2	30.5	24.8	14.8	6.5	---	---	---	---
NDOT Specification centermount 3 inch						25.0	25.0		50.0					25.0								
Centermount, 3 inch	---	---	0.2	2.3	11.1	21.8	44.0	59.2	67.7	74.5	77.2	74.9	72.4	59.2	43.3	21.2	11.0	2.2	0.2	---	---	---
Reflective Sheeting, Type 3, 10 sq in.	0.1	1.2	4.8	10.5	15.3	16.6	17.4	17.8	18.0	18.1	18.7	18.1	18.0	17.8	17.4	16.6	15.3	10.5	4.8	1.2	0.1	0.1
60 Degree Orientation NFS, Laboratory No. 78 RD-290A	14.8	24.8	36.2	46.2	61.8	60.5	38.9	38.5	36.4	32.3	29.6	23.7	19.0	14.1	9.5	5.8	2.5	0.2				
Centermount, 3 inch	2.3	11.1	44.0	67.7	77.2	74.9	72.4	59.2	43.3	21.2	11.0	5.2	2.2	0.8	0.2	0.3						
Reflective Sheeting, Type 3, 10 sq in.	9.9	14.8	17.2	18.0	18.7	18.1	16.0	17.8	17.4	16.6	15.3	13.3	10.5	7.6	4.8	2.6	1.2	0.1				
45 Degree Orientation NFS, Laboratory No. 78 RD-290A	30.5	41.9	49.4	60.5	68.5	66.4	32.3	29.6	23.7	19.0	14.1	9.5	5.8	2.5	1.1	0.2	---	---	---	---	---	---
Centermount, 3 inch	21.8	59.2	74.5	74.9	59.2	43.3	21.2	11.0	5.2	2.2	0.8	0.2	0.3									
Reflective Sheeting, Type 3, 10 sq in.	16.2	17.7	18.1	18.1	17.8	17.4	16.6	15.3	13.3	10.5	7.6	4.8	2.6	1.2	0.5	0.1						
80 Degree and 0 Degree Orientation Not Practical.																						
Two Delineators one at 90 degrees and one at 45 degrees																						
Centermount, 3 inch	21.8	59.2	74.7	77.2	70.3	65.1	65.2	70.2	72.9	76.7	78.0	75.1	72.7	59.2	43.3	21.2	11.0	2.2	0.2			
Reflective Sheeting, Type 3, 10 sq in.	16.3	18.9	22.9	28.6	33.1	34.0	34.0	34.1	31.3	28.6	26.3	22.9	20.6	19.0	17.9	16.7	15.3	10.5	4.8	1.2	0.1	0.1



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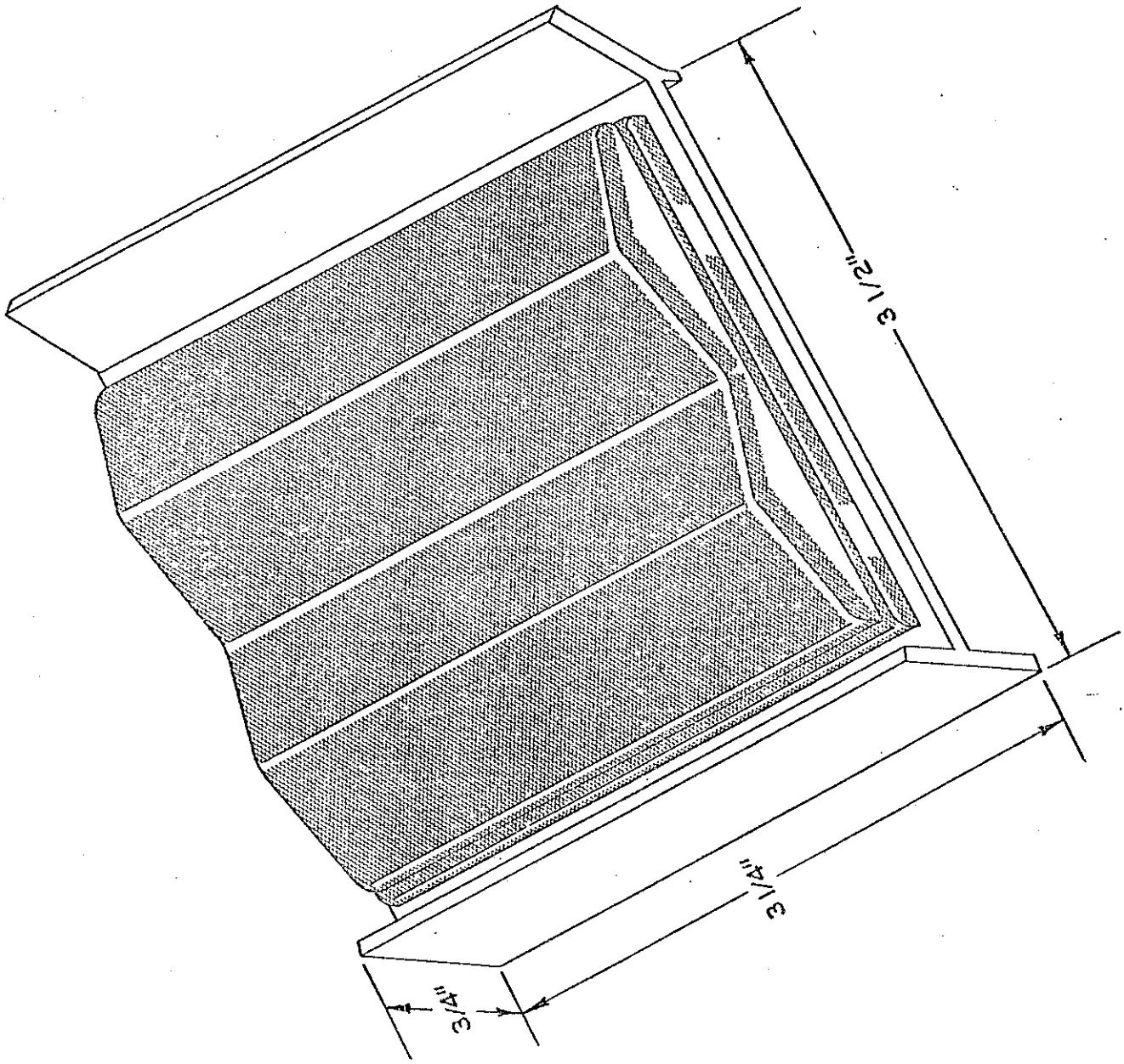


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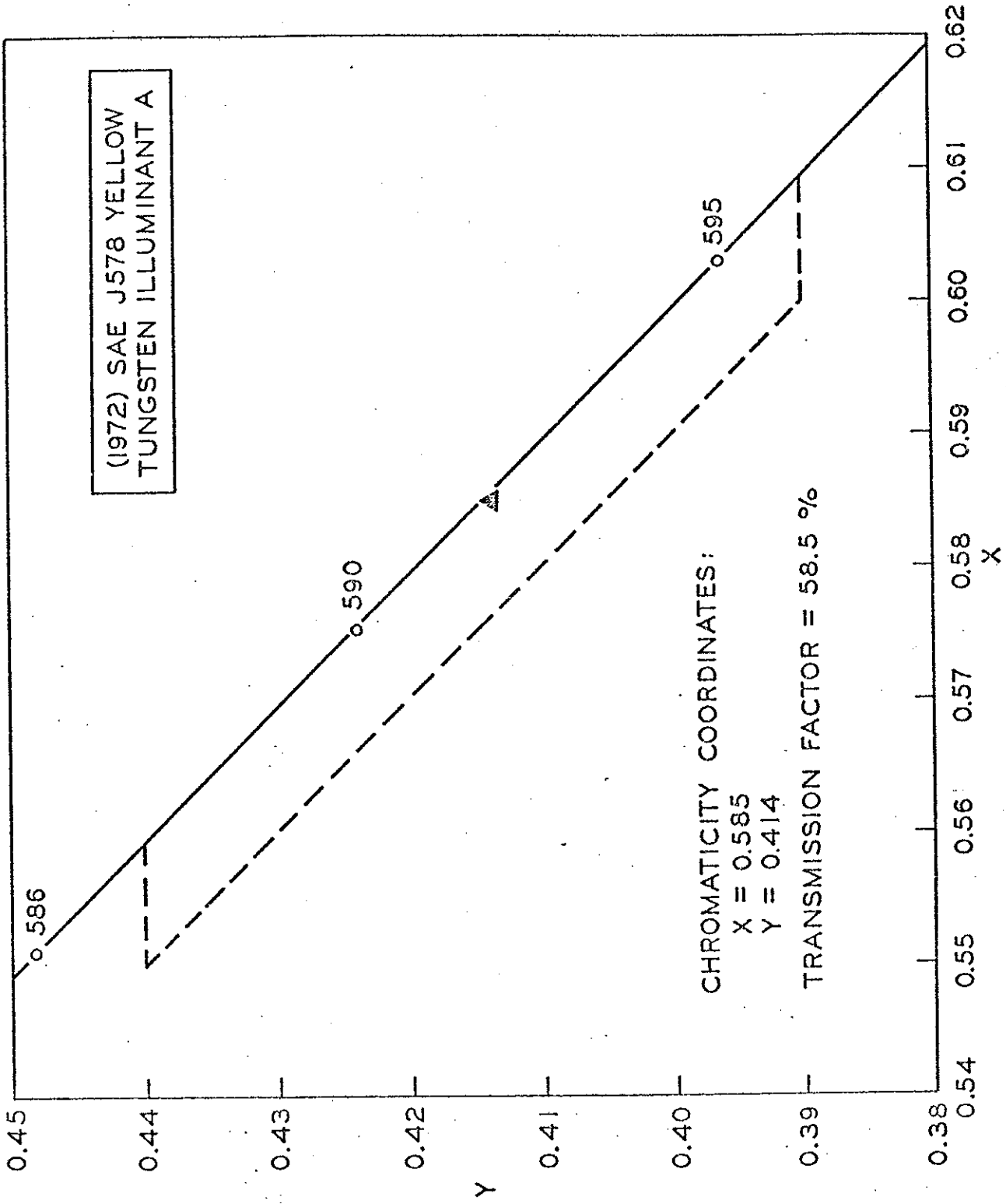


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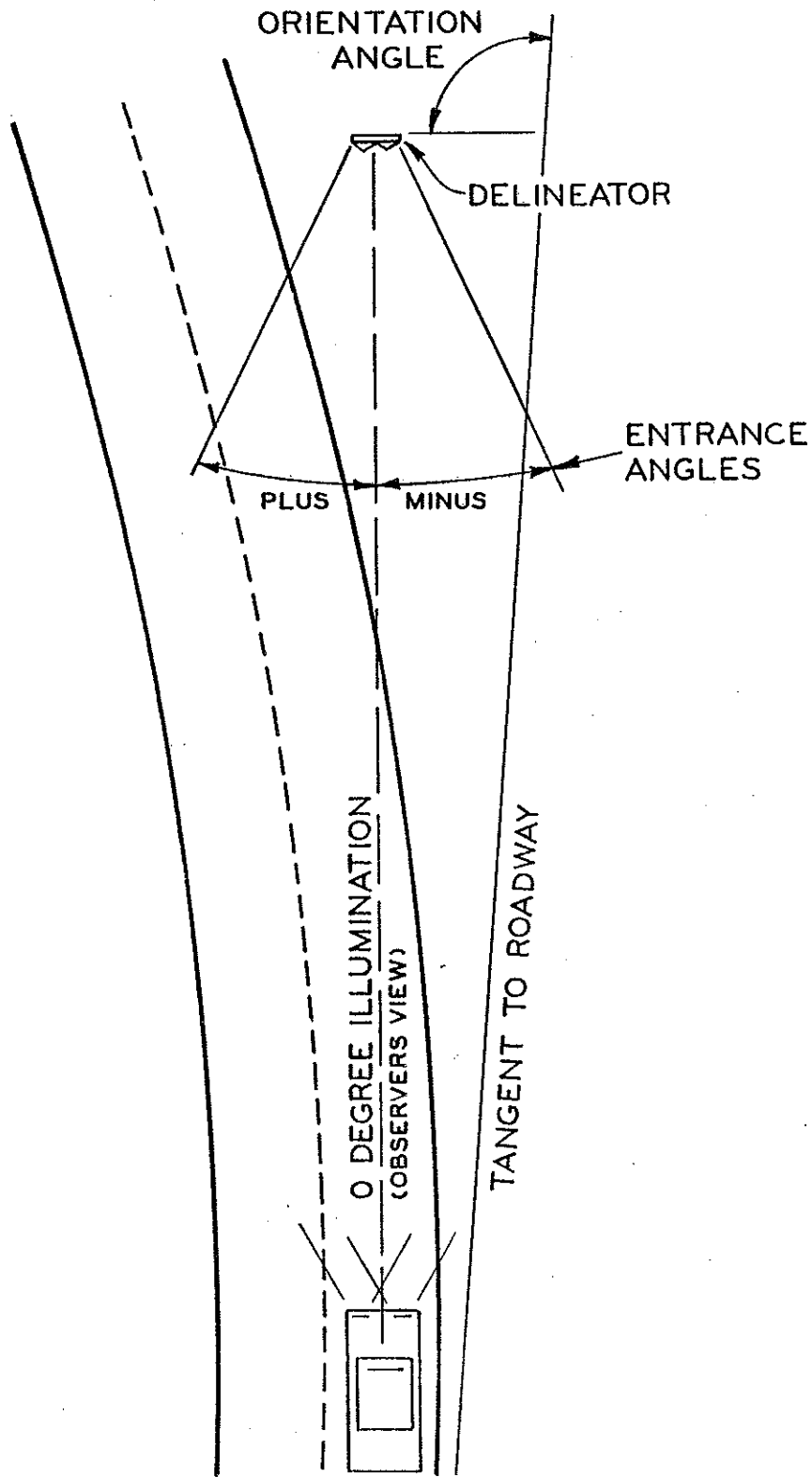


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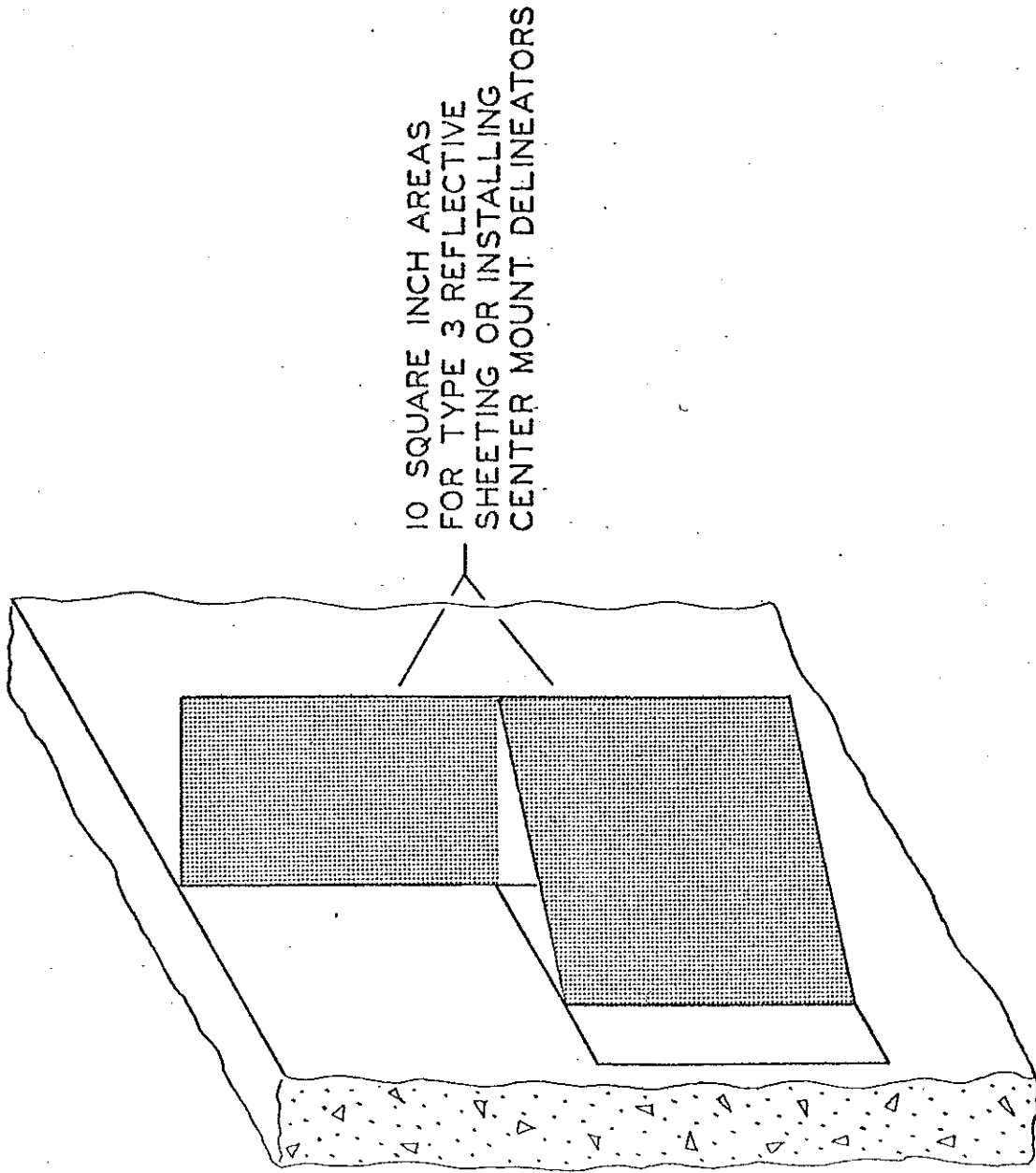


Figure 4. Proposed delineator assembly for concrete barrier.



Table 1

Specific Luminance of NFS Model 160 Crystal Delimiters

Delimiter Identification and Mounting Orientation	Specific Luminance cp/(ft./unit) at 0.2 Deg Divergence																					
	70	60	50	40	30	25	20	15	10	5	0	5	10	15	20	25	30	40	50	60	70	
90 Degree Orientation NFS, Laboratory No. 78 RD-291A	0.8	3.0	8.2	20.4	35.0	40.4	44.1	48.5	50.6	51.5	86.8	79.6	66.8	63.1	55.1	46.8	39.0	22.0	10.5	10.5		
NFS, Laboratory No. 78 RD-291B	0.6	2.1	10.5	21.9	34.9	39.1	43.8	44.9	45.6	71.8	81.1	68.9	62.2	58.3	52.2	44.1	36.5	20.7	9.5	9.5		
MDOI Specifications, centermount, 3 inch							42.0				84.0				42.0							
Centermount, 3 inch	---	0.2	0.8	5.7	25.6	49.5	97.2	131.4	150.0	161.0	165.8	161.0	150.0	131.4	96.3	48.2	25.1	5.7	0.8	0.2		
Reflective Sheeting, Type 3, 10 sq in.	0.1	1.0	4.4	10.0	15.8	18.1	19.8	20.8	21.4	21.7	22.3	21.9	21.5	21.2	20.3	18.7	16.4	10.3	4.2	0.9	0.9	
60 Degree Orientation NFS Laboratory No. 78 RD-291A	20.4	35.0	44.1	50.6	86.8	79.6	66.8	63.1	55.1	46.8	39.0	30.9	22.0	16.3	10.5							
Centermount, 3 inch	5.7	25.6	97.2	150.0	165.8	161.0	150.0	131.4	96.3	48.2	25.1	13.0	5.7	2.2	0.8	1.0	0.2	---	---	---		
Reflective Sheeting, Type 3, 10 sq in.	10.0	15.8	19.8	21.4	22.3	21.9	21.5	21.2	20.3	18.7	16.4	13.6	10.3	6.9	4.2	2.1	0.9	0.1	---	---		
45 Degree Orientation NFS, Laboratory No. 78 RD-291A	40.4	48.5	51.5	79.6	63.1	55.1	48.5	39.0	30.9	22.0	16.3	10.5										
Centermount, 3 inch	49.5	131.4	161.0	161.0	134.4	96.3	48.2	25.1	13.0	5.7	2.2	0.8	1.0	0.2								
Reflective Sheeting, Type 3, 10 sq in.	18.1	20.8	21.7	21.9	21.2	20.3	18.7	16.4	13.6	10.3	6.9	4.2	2.1	0.9	0.3	0.1						
30 Degree and 0 Degree Orientations Not Practical																						
Two Delimiters one at 90 degrees and one at 45 degrees																						
Center Mount, 3 inch	49.5	131.6	161.8	166.7	157.0	145.8	145.4	156.5	163.0	166.7	169.0	161.8	151.0	131.6	96.3	48.2	25.1	5.7	0.8	0.2	---	
Reflective Sheeting, Type 3, 10 sq in.	18.2	21.8	26.1	31.9	37.0	38.4	38.5	37.2	35.0	32.0	29.2	26.1	23.6	22.1	20.6	18.8	16.4	10.3	4.2	0.9	0.1	

Table 2

## Specific Luminance of NFS Model 160 Yellow Delimiters

Delimiter Identification and Mounting Orientation	Specific Luminance cp/ftc/unit at 0.2 Deg Divergence																					
	Entrance Angles																					
	70	60	50	40	30	25	20	15	10	5	0	5	10	15	20	25	30	40	50	60	70	
90 Degree Orientation																						
NFS, Laboratory No. 78 RD-290A	0.2	2.5	9.5	19.0	29.6	32.3	36.4	38.5	38.9	60.5	61.8	49.4	40.2	41.9	36.2	30.5	24.8	14.8	6.6	---	---	---
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MDOT Specification centermount 3 inch							25.0			50.0					25.0							
Centermount, 3 inch	---	---	---	0.2	2.3	11.1	21.8	44.0	59.2	67.7	74.5	77.2	74.9	72.4	59.2	43.3	21.2	11.0	2.2	0.2	---	---
Reflective Sheeting, Type 3, 10 sq in.	0.1	1.2	4.8	10.5	15.3	16.6	17.4	17.8	18.0	18.1	18.7	18.1	18.0	17.8	17.4	16.6	15.3	10.5	4.8	1.2	0.1	0.1
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Two Delimiters																						
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Reflective Sheeting, Type 3, 10 sq in.	16.3	18.9	22.9	28.6	33.1	34.0	34.0	34.1	31.3	28.6	28.3	22.9	20.6	18.0	17.9	16.7	15.3	10.5	4.8	1.2	0.1	0.1