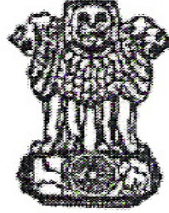


भारत सरकार
Government of India
रेल मंत्रालय
MINISTRY OF RAILWAYS



सत्यमेव जयते

Provisional Specification for
Retro-reflective Indicators

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Provisional Specification for Retro reflective Engineering Indicators

1.0 Scope

This specification covers the Engineering indicators using high intensity retro-reflective sheeting typically manufactured as an encapsulated glass bead retro-reflective material and as an unmetallised micro prismatic retro-reflective element material referred to as type III & type IV sheeting respectively in ASTM D4956-09.

2.0 General

The colour configuration, size and location of all Engineering Indicators shall be in accordance with Annexure 8/3 and 8/4 to para 807 & 808 of IRPWM 2004. The sign must be reflectorised and have better retro-reflectance (a process that returns light towards its source) at night and at wide entrance angle as well as in straight approach.

3.0 Material

3.1 Aluminium

3.1.1 Aluminium sheet used for sign board shall be of a smooth hard and corrosion resistant Aluminium Alloy conforming to IS-736 designated 24345 or 19000. The thickness of aluminium sheet shall be 14 gauge (2mm) minimum and shall be related to size of the sign board so that it does not bend & deform from wind pressure. The contractor/supplier of the sign board shall obtain test certificate in support of the material conforming to IS-736 from the manufacturer of the aluminium sheet for each batch to be used for the sign boards and submit the same to the purchaser.

3.1.2 Elongation and Tensile strength

Aluminium piece of size 25mm in width and 350mm in length shall be fixed with gripping tools, leaving a length of 25mm from each end free to make the gripping distance 300mm. The number of test pieces shall be three and elongation shall not be less than 10% and tensile strength shall not be less than 22N/mm².

3.2 Retro reflective sheeting

3.2.1 General requirements

The retro reflective sheeting used on the sign shall consist of the white or coloured sheeting having smooth outer surface which has the property of retro-reflection over its entire surface. It shall be weather resistant and show colour fastness. It shall be new, unused and shall show no evidence of cracking, sealing, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for these properties in an unprotected outdoor exposure facing the sun for two years and its having passed these tests at the time of initial development of the material shall be obtained from a reputed laboratory by the manufacturer of the sheeting.

3.2.2 Sheeting

The sheeting shall be of encapsulated lens type consisting of spherical glass lens, elements adhered to a synthetic resin and encapsulated by a flexible, transparent, waterproof plastic having a smooth surface conforming to requirements of type III sheeting as per ASTM D 4956-09 or unmetallised micro prismatic material with high density of microscopic prism elements adhered to by a synthetic resin and encapsulated by a flexible, transparent, weather proof plastic having smooth outer surface conforming to requirements of type IV sheeting as per ASTM D 4956-09 as the case be.

3.2.3 Colour

The colour of the retro-reflective sheet shall conform to the requirements of Table 1 and Table 2 below when tested in accordance with para 3.2.3.1 below.

Table 1- Daytime luminous factor Y (%)

Colour	Minimum	Maximum
White	27	-
Yellow	15	45
Red	2.5	15

Table 2- Colour specification limits (Daytime)

Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346

3.2.3.1 Day time Colour:

Determine the chromaticity and luminance factor Y (%) for CIE standard illuminant D65 and the 1931 CIE 2° standard observer in accordance with Practice ASTM E308, Test Methods ASTM E1347, ASTM E1349, and ASTM E2301, and Practices ASTM E991, ASTM E1164, ASTM E2152, and ASTM E2153, as applicable. The luminance factor is the sum of the reflectance luminance factor and the fluorescence luminance factor. Bispectral measurement provides the individual factors, while measurement with simulated D65 provides their sum.

3.2.3.1.1 For fluorescent specimens, it is necessary either that the physical illumination of the specimen be a good approximation to illuminant D65, requiring an instrument with an appropriately filtered light source, or else that a bispectral photometer conforming to Test Method ASTM E2301 be used.

3.2.3.1.2 There are three types of 45/0 (0/45) instruments: annular, circumferential, and uniplanar (see Fig. 1). Measurement of prismatic sheeting with circumferential instruments may require multiple measurements. Measurement of prismatic sheeting with uniplanar instruments definitely requires multiple measurements.

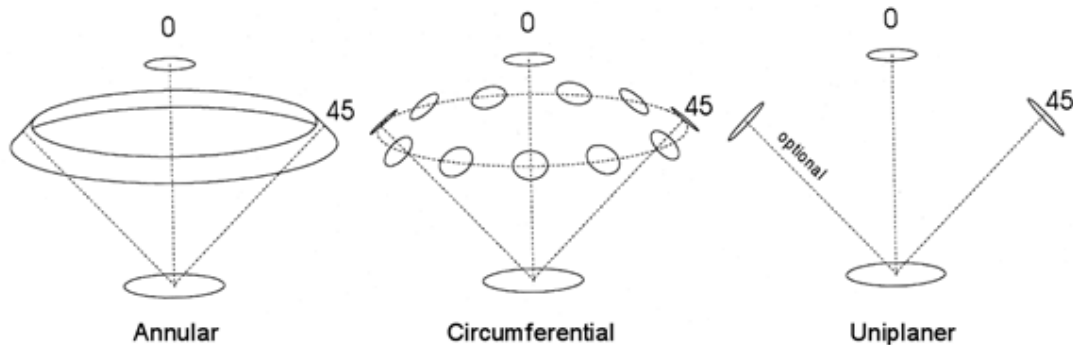


Figure 1 : Three Types of 0/45 (45/0) Instruments

3.2.3.1.3 If the measurement geometry is circumferential, then the testing laboratory must verify that the apertures in the ring are sufficiently close for acceptable approximation to an annular measurement. This may depend on the optical construction of the specimen, and must be determined by the testing laboratory. Multiple measurements of the same specimen area at different rotations may be averaged to improve the approximation to an annular measurement.

3.2.3.1.4 If the measurement geometry is uniplanar, then a sequence of measurements shall be made on the same specimen area at incremental rotations, and the measurement values shall be taken as averages over all the rotations. The number of rotations shall be large enough for acceptable approximation to an annular measurement. The number depends on the optical construction of the specimen and must be determined by the testing laboratory.

3.2.3.1.5 Instruments (spectrophotometers, colorimeters) used to measure daytime colour shall have 45/0 or 0/45 illumination and viewing geometry. The referee instrument shall have 10° apertures for both illumination and viewing. Use of aperture sizes deviating from these may affect the measurement results.

3.2.4 Coefficient of Retro-reflection:

The coefficient of retro-reflection shall meet or exceed the minimum requirements for the relevant type of sheeting i.e. as per table 3 below for type III sheeting as per ASTM D4956-09 (high intensity encapsulated type) or as per table 4 below for type IV sheeting as per ASTM D4956-09 (high intensity micro prismatic type) determined in accordance para 3.2.4.1 below.

Table 3 - MINIMUM COEFFICIENT OF RETRO REFLECTION FOR TYPE III HIGH INTENSITY GRADE SHEETINGS (ENCAPSULATED LENS TYPE)

(Candelas per lux per square metre)

Observation Angle	Entrance angle	White	Yellow	Red
0.1 ⁰	-4 ⁰	300	200	54
0.1 ⁰	+30 ⁰	180	120	32
0.2 ⁰	-4 ⁰	250	170	45
0.2 ⁰	+30 ⁰	150	100	25
0.5 ⁰	-4 ⁰	95	62	15
0.5 ⁰	+30 ⁰	65	45	10

Table 4 - MINIMUM COEFFICIENT OF RETRO REFLECTION FOR TYPE IV HIGH INTENSITY MICRO-PRISMATIC GRADE SHEETINGS

(Candelas per lux per square metre)

Observation Angle	Entrance angle	White	Yellow	Red
0.1 ⁰	-4 ⁰	500	380	90
0.1 ⁰	+30 ⁰	240	175	42
0.2 ⁰	-4 ⁰	360	270	65
0.2 ⁰	+30 ⁰	170	135	30
0.5 ⁰	-4 ⁰	150	110	27
0.5 ⁰	+30 ⁰	72	54	13

When totally wet the sheeting shall not show less than 90 per cent of the values of retro-reflectance indicated in above table. At the end of 7 years, the sheeting shall retain at least 80 percent of its original retro reflectance. The co-efficient of retro-reflection shall be determined in accordance with ASTM E:810.

3.2.4.1 For lots, rolls, or sheets of retro-reflective sheeting at least 1 yd (0.914 m) long in new (unexposed) condition, take 3 samples in accordance with 3.2.4.1.1 to 3.2.4.1.5 below and determine the coefficients of retro-reflection in accordance with Test Method ASTM E810.

3.2.4.1.1 To determine conformance to requirements for Coefficients of Retro-reflection for rolls or sheets at least 1 yd (0.914m) long of retro-reflective sheeting in new (unexposed) condition:

3.2.4.1.2 A full width X 1 yd (0.914 m) long specimen is selected at random to represent the entire sheet, roll, or lot.

NOTE 1—Samples smaller than 1 yd (0.914 m) long should not be used to judge conformance for full rolls or lots.

3.2.4.1.3 Three samples are taken from the selected specimen.

3.2.4.1.4 The three samples shall be spaced evenly across (left, center, right) and spaced evenly down the specimen as shown in the examples in figure 2 below.

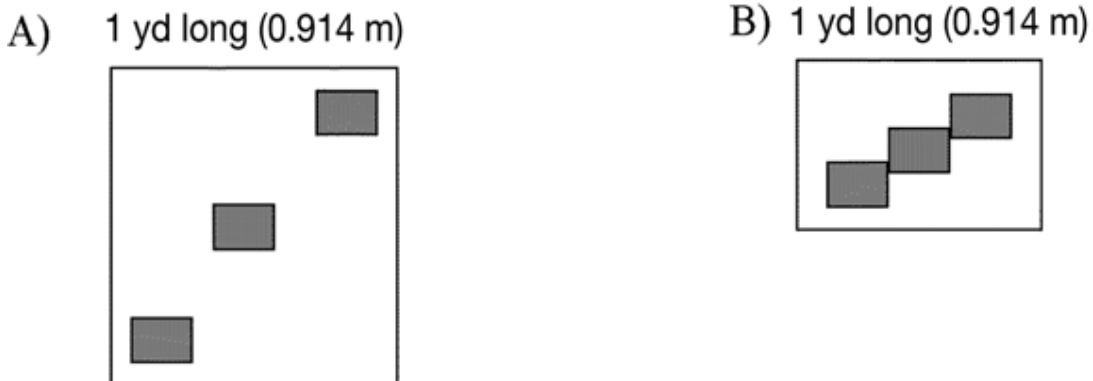


Figure 2: Examples of Proper Spacing for Samples

3.2.4.1.5 To conform to this specification, the average of the 3 coefficients of retro-reflection shall meet the minimum limits given in 3.2.4 above and none of the coefficients of retro-reflection obtained on any of the samples shall be less than 80 % of the values required in 3.2.4.

3.2.5 Accelerated Out Door Weathering Requirement

The retro-reflective sheeting shall be weather resistant and show no appreciable cracking, scaling, pitting, blistering, edge lifting, or curling, or more than 1/32-in. (0.8-mm) shrinkage or expansion when tested in accordance with 3.2.5.1 below. Conduct retro-reflectivity measurements after outdoor weathering at 0.2° observation and -4° and +30° entrance angles. The minimum coefficient of retro-reflection (RA) after weathering is specified in Table 5 below.

Table 5: Outdoor Weathering Photometric Requirements for All Climates

Type of Sheeting	Months	Minimum Coefficient of Retro reflection, RA
III	36	80% of table 3
IV	36	80% of table 4

NOTE 2—Supplementary Requirement S3 of ASTM D 4956-09 describes a method for artificial accelerated weathering, which users of this specification may employ for preliminary judgment until outdoor weathering results are available.

3.2.5.1 **Outdoor Weathering**—Conduct outdoor exposures in accordance with Practice ASTM G7. During exposure, test panels shall be open backed and oriented at an angle of 45° from the horizontal and facing the equator in accordance with Practice ASTM G7. Expose two panels per location for the number of months specified in Table 5. Conduct exposures in the climate types shown in Table 6 below. Panel labeling, and conditioning and handling of panels prior to exposure and during evaluation periods shall be in accordance with Practice ASTM G147.

TABLE 6 : Climate Types for Use in Outdoor Exposures of Retro-reflective Sheetings

Temperature, °F (°C) Climate Type	Mean Monthly	
	Warmest Month	Coldest Month
Tropical summer rain	82 to 93 (28 to 34)	64 to 72 (18 to 22)
Desert	82 to 93 (28 to 34)	50 to 63 (10 to 17)

(Optional,
but recommended) Climate mutually agreed upon between the purchaser and the seller

3.2.5.1.2 **Washing Panels After Exposure**—Following exposure, gently wash the panels using a soft cloth or sponge and clean water or a dilute solution of a mild detergent (1 % by weight in water, maximum concentration). After washing, rinse thoroughly with clean water, and blot dry with a soft clean cloth. After washing and drying, condition the panels at room temperature for at least 2 hours prior to conducting any property measurements.

3.2.5.1.3 **Measurement of Coefficient of Retro-reflection**—After panels have been washed, dried, and conditioned in accordance with 3.2.5.1.2, measure retro-reflectance at 0.2° observation and -4° and +30° entrance angles. Report the average of the coefficient of retro-reflection measured at each geometry on the two panels from each exposure location.

NOTE 3—The use of two samples per weathering deck is considered a minimum and reflects historical practice and practicality. Additional samples may be weathered, and the results averaged, to decrease the effects of variability associated with the weathering process.

NOTE 4—Weathering tests are generally performed less frequently than other tests in this specification. Judgment must be used to satisfy the user that weathering results obtained on exposed samples are sufficiently applicable to the material being supplied

3.2.6 Colour fastness—Use one of the outdoor weathered specimens to test for colour fastness. Wash, dry, and condition panels in accordance with 3.2.5.1.2 and test as specified in 3.2.3.1.

3.2.7 Night time Color— The night time color of the sheeting shall conform to the requirements of Table 7, when tested in accordance with 3.2.7.1 below.

3.2.7.1 Test for night time color. Determine the chromaticity in accordance with Practice ASTM E811 and evaluated using the CIE system in accordance with Practice ASTM E308. (The saturation limit shall be considered to extend to the boundary of the chromaticity locus of spectral colors.) Measure using CIE Illuminant A, observation angle of 0.33 degrees, entrance angle of +5 degrees, source and receiver apertures not to exceed 10 minutes of arc, and CIE 1931 (2 degree) standard observer.

Table 7: Colour Specification Limits (Night Time)

Colour	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	No requirement							
Yellow	0.513	0.487	0.500	0.470	0.545	0.425	0.572	0.425
Red	0.650	0.348	0.620	0.348	0.712	0.255	0.735	0.265

3.2.8 Shrinkage

Retro reflective sheets shall not shrink by 0.8 mm or more in 10 minutes and by 3.2 mm or more in 24 hrs respectively when tested as under :-

Three pieces of size 230mm X 230mm of the retro reflective sheeting with liner shall be accurately measured and kept for a minimum of one hour at a temperature of 23± 2 degree centigrade and 50±5% relative humidity. Remove the liner and place the specimen on a flat surface with the adhesive side up. Ten minutes after the liner is removed and again after 24 hours, measure the specimen to determine the amount of dimensional changes.

3.2.9 Flexibility

The Retro reflective sheets shall not show any defects such as fissure, crack etc. on their surface when tested as under :-

Bend the sheeting in one second, around a 3.2mm mandrel with adhesive contacting the mandrel. For ease of testing, spread talcum powder on the adhesive to prevent sticking to the mandrel. The test specimen shall be 70 mm in width and 230mm in length and three in numbers. The test temperature shall be 23±2 degree centigrade.

3.3 Adhesive

The pre-coated adhesive shall be such that no further application of adhesive is necessary. The manufacturer of the material shall supply instructions for its application in sufficient detail to ensure that the adhesive performance requirements can be met when the material is applied in accordance with such instructions. The adhesive shall be protected by an easily removable liner attached to the adhesive surface (removable by peeling without soaking in water or other solvent and tearing, breaking or removing any of the adhesive from the back of the material) and shall be suitable for the type of material of the base plate. The adhesive shall form a durable bond to smooth, corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. Adhesion when tested in accordance with clause 7.5 of ASTM D-4956-09 the adhesive backing of the retro-reflective sheeting shall produce a bond that will support 0.79 kg weight minimum, without the bond peeling for a distance of more than 51mm. Unless otherwise specified in this specification all adhesively bonded and unbounded test samples and specimens shall be conditioned at a temperature of $23\pm 2^{\circ}\text{C}$ and $50\pm 5\%$ relative humidity for 24 hours prior to testing.

4.0 Fabrication

Surface to be reflectorised shall be effectively prepared to receive the retro-reflective sheeting. The Aluminium sheeting shall be de-greased either by acid or hot alkaline etching and all scales/ dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves, between all cleaning and preparation, operation and application of reflective sheeting/primer, there shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting. Complete sheets of the material shall be used on the signs and no splices/overlap shall be permitted.

5.0 Warranty and Durability

For each lot of sheeting procured, the contractor/ supplier shall obtain from the manufacture of the sheeting a ten year warrantee for satisfactory field performance including stipulated retro-reflectance of the retro-reflective sheeting of high intensity encapsulated type or micro prismatic type as the case be and submit the same to Engineer. In addition, a ten year warrantee for satisfactory in-field performance of finished sign with retro-reflective sheet inclusive of screen printed or cut out letters/ legends and their bonding to retro-reflective sheeting shall be submitted by the contractor/ supplier to the Engineer. The contractor/ supplier shall also furnish a certificate that the sign and material supplied against the assigned work meet all the stipulated requirements and carry the stipulated warrantee. All sign shall be dated during fabrication with indelible (permanent/ ineradicable) marking to indicate the start of warrantee. The warrantee shall also cover the replacement obligation by sheeting manufacturer as well as contractor/ supplier for replacement/ repair/ restoration of retro-reflective efficiency.

6.0 Packing and marking

The sheet & rolls manufactured under this specification shall be packed in accordance with commercially acceptable standard. Each package shall be indelibly marked with following at a suitable location on each package:

Manufacturer's Name, Brand or Trade Mark ,

Lot or Run Number,

Quantity, Part Number, Size,

Month and year of manufacture.

7.0 Test Certificate and Testing of Material

7.1 Following test certificates shall be obtained by the purchaser/approving agency from the contractor/supplier of the sign board while passing the material/approving the firm :

S.N.	Test Certificate Requirement	Remarks
1.	Certificate from manufacturer of sheeting of having tested the sheeting from reputed laboratory in an unprotected outdoor exposure facing the sun for two years at the time of initial development of material and having passed the tests.	As detailed in para 3.2 above.
2.	Copy of test certificate from manufacturer of sheeting for retro-reflectance and weather resistance done at the time of initial development of material.	As detailed in sub-para (i) below.
3.	Certificate from manufacturer regarding no significant change in manufacturing process after initial development of material.	As detailed in sub-para (i) below.
4.	Copy of test results for the particular lot of supply of sheeting conforming the specification requirements with a certificate from manufacturer.	As detailed in sub-para (ii) below.
5.	Test certificate for aluminium sheet confirming to specification.	As detailed in sub-para (iii) below.
6.	Results of the tests carried out by the contractor/supplier of sign board.	As detailed in sub-para (iv) below.

- i) A copy of the test certificate, done originally on the product (retro-reflective sheet) at the time of initial development of material by an independent test house, for the retro-reflectance values and weather resistance test determined in accordance with ASTM standard E:810 and ASTM D-4956-09 respectively and a certificate from the manufacturer of the sheeting stating that since this testing of the sheeting there has neither been any significant change in the manufacturing process of the sheeting nor any ingredient has changed, and hence the test results supplied by him as above are valid for the current lot also.
 - ii) A certificate from the manufacturer of the retro-reflective sheeting stating that the material being supplied under the purchase order has been tested and is conforming to the standards specified for the sheeting. This certificate should be accompanied with a copy of the test results of the particular lot for retro-reflectance of the sheeting determined in accordance with ASTM standard E:810, and Color of retro-reflective sheeting, Adhesion, Shrinkage, Flexibility, Liner Removal and Impact Resistance as specified and determined in accordance with ASTM D:4956-09.
 - iii) Test certificate as per para 3.1 for each batch of the Aluminium sheet to be used for the sign board from the manufacturer of the Aluminium sheet for tests carried out in in-house test laboratory or through an independent test house.
 - iv) Results of the test carried out on samples of Aluminium sheet and Retro-reflective sheeting as specified in para 3.1.2 by in-house testing facility available with the contractor/supplier of the sign boards or through an independent test house. For each test specified above, one sample consisting of at least three test pieces shall be collected for every one hundred or part thereof of the sign boards. Every test piece so tested should pass the tests.
- 7.2** The purchaser/approving agency shall be free to get these test results verified for which necessary facility/means shall be provided by the supplier at his own cost. The purchaser/approving agency at his discretion may like to get these tests done at independent approved test house as a part of the quality audit. Results of such tests conducted in approved test house shall be binding upon the supplier.