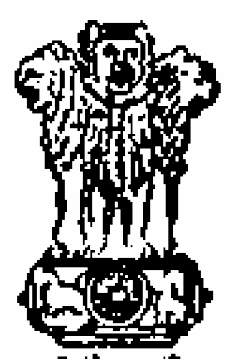

INDIAN RAILWAYS STANDARD SPECIFICATION FOR ROUNDELS AND LENSES
(TENTATIVE)

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AMENDMENTS

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Amendments 1, 2, 3 & 4 have been incorporated in the specification.

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GOVERNMENT OF INDIA
(MINISTRY OF RAILWAYS)
RESEARCH DESIGNS & STANDARDS ORGANISATION

INDIAN RAILWAYS STANDARD SPECIFICATION
for
ROUNDELS AND LENSES
(TENTATIVE)

0. FOREWORD

0.1 This Specification is issued under the fixed serial No. S 7. The final number indicates the year of original adoption as standard or in case of revision, the year of last revision.

ADOPTED 1932; REVISED 1934, 1937, 1959, 1961, 1976, 1989 AND 1992.

0.2 This specification requires reference to the following Indian Railway Standard (IRS), Indian Standard, British Standard and ASTM Specifications;

IRS: S23	Electrical and Electronic based signalling and interlocking equipment.
IS: 1382	Glossary of terms relating to glass industry.
IS: 2303	Methods of grading glass for alkalinity.
BS: 4432 (Pt. I)	Measurement of diffuse reflectance factor, paper, board & pulps.
BS: 1376	Colours of light signals.
ASTM: C 169	Methods for chemical analysis of Sodalime and Borosilicate glass.
ASTM:D 256	Test method for impact resistance of plastics and electrical insulating materials.
ASTM:D 638	Methods for test for tensile properties of plastics.

ASTM:D 785 Test method for Rockwell hardness of plastics and electrical insulating materials.

ASTM:D 792 Method for test for specific gravity and density of plastics by displacement.

ASTM: G 53-88 Standard Practice for Operating Light and Water Exposure Apparatus (Fluorescent UV- Condensation Type) for exposure of Non-metallic Materials **-Amendment 2**

ASTM: D 1003 Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics **-Amendment 2**

0.3 Wherever in this specification, any of the above mentioned specification is referred to by number only without mentioning the year of issue, the latest issue of the specification is implied, otherwise the particular issue referred to is meant.

0.4 This specification is intended chiefly to cover the technical provisions and it does not include all the necessary provisions of a contract.

1. SCOPE

1.1 This specification covers the technical requirements of roundels and lenses moulded from glass or polycarbonate material for use in railway signalling.

2. TERMINOLOGY

2.0 For the purpose of this specification, in addition to the terminology, given in IRS: S23, IS: 1382 and BS: 1376, the following definition shall apply.

2.1. **Step-Lens**- A lens in which one face is continuously curved and the other face consists of discontinuous sections of lens formation.

2.2 **Inside step lens**- A lens in which the discontinuous sections come on the concave surface of the lens.

2.3 **Outside step lens**- A lens in which the discontinuous sections come on the convex surface of the lens.

2.4 **Face of the Discontinuous sections-**

This is divided into:-

a) the ‘Zones’ the profile of which should accurately moulded to give the desired focus the lens or the combination for which this is intended.

b) the 'Risers' which connect and step the zone over the surface.

Zones and Risers may be identified by counting from the centre to the rim of the lens, centre lens formation being the first zone.

2.5 **Working Focal Length -** The axial distance between the plane of lens seating and the point along the axis at which, when a point source of light is placed, the lens as a whole transmits as near as possible a parallel beam of light. In the case of a doublet combination of lenses, focal length is referred to from the seating of the inner outside step lens.

2.6 **Nominal Focal Length -** The focal length for which the lens is designed.

2.7 **Angles of Spread -** The angle included by that portion of the beam within which the intensity of the beam is not less than 50 per cent of the candle power of the axial beam.

2.8 **Colour** - The colour of a light signal is defined in terms of its chromaticity coordinates using the trichromatic system recommended by the International Commission on Illumination in 1931. In this system, the colour is expressed in the chromaticity coordinates, x, y and z, the sum of which is unity. The coordinate x is analogous to the proportion of red, y to the proportion of green and z to the proportion of blue.

2.9 **Luminance** – The luminous intensity of the light emitted per unit projected surface area.

2.10 **Colour Limits** – Colour limits are stated in terms of limiting values of some or all of the three chromaticity coordinates x, y and z.

2.11 **Colour filter** – A selective filter that makes a significant change to the chromaticity of the light passing through it.

2.12 **Chromaticity of a filter** – The chromaticity of a filter is defined by the chromaticity coordinates of the light reflected from a truly white screen (e.g. magnesium-oxide screen) illuminated only by light which passed through the filter in the manner intended in service *.

* For the purpose of this specification, the light source is deemed to be illuminant A of the International Commission on illumination i.e. a tungsten fitment lamp operated at a colour temperature of 2854 deg. K

2.13 **Transmittancy of a colour filter** – The transmittancy of a colour filter is defined as the percentage ratio of the luminance of a truly white screen, illuminated as in 2.12 above, to the lumination of the same screen when the colour filter is replaced by a non-absorbing medium of the same pattern and refractive index.

2.14 **Magnesium Oxide Screen** – A silvered plate on which pure magnesium oxide has been freshly deposited to a thickness of at least 1 mm and manifesting no discontinuity when examined with the naked eye, or a screen of compressed magnesium oxide or barium sulphate powder as described in BS: 4432 Part I.

3.0 GENERAL REQUIREMENTS

3.1 The roundels and lenses shall conform to the dimensions given in the drawings approved by the purchaser.

3.2 The roundels and lenses shall be of types and colours given in Table 1 of this specification. The class of colours shall be as per Table 2 of BS: 1376 (reproduced in Appendix C). The details for the procurement of roundels and lenses shall be furnished by the purchaser as per Appendix "A".

3.3 The lenses and roundels shall be made of glass or ultra violet stabilised polycarbonate material which shall be durable on prolonged exposures to weather.

3.4 The colour of roundels and lenses shall be red, green, yellow, lunar white or clear as specified by the purchaser. The coloured roundels and lenses shall have uniform colour.

3.5 The colour and transmittancy (transmittance) of roundels and lenses shall conform to Table 1 and Table 5 of BS: 1376 respectively (reproduced in Appendix "C").

3.6 The roundels and lenses shall be accurately moulded and shall be as far as possible free from moulding defects such as streaks, warps, seeds, bubbles, blisters, etc. as defined in IS: 1382. The seating surface of roundels and lenses shall be free from fins.

3.7 The roundels and lenses made of glass material shall be properly annealed after moulding to keep down the strains to a minimum. The annealing temperature shall be about 550 deg C for a period of 30-45 minutes. The roundels and lenses made of polycarbonate material shall also be annealed after moulding at a temperature of about 125 deg. C for 2 hours.

3.8 The lens or doublet combination of lenses shall not have dark annular rings but shall flash uniformly when a point source of light is placed at the focal point.

3.9 Spreadlight Lenses shall have a horizontal spread of 8 ± 1deg. unless specified otherwise by the purchaser.

3.10 The roundels shall be accurate to the sizes and tolerances specified by the purchaser. The lenses shall be accurate to the sizes specified by the purchaser subject to the following tolerances on diameter:

a)	Outside step lens for the inner lens of doublet combination.	+ 0.0 mm - 1.0 mm
b)	Inside step lens upto 160 mm dia.	+ 0.0 mm - 1.5 mm
c)	Inside step lens over 160 mm dia	+ 0.0 mm - 3.0 mm

3.11 The focal length of lenses shall be within ± 3mm for all inside step lenses and ± 1.5 mm for doublet combination of lenses.

4.0 MARKING

4.1 ~~The roundels and lenses shall be clearly and indelibly marked and indicate:~~
The roundels and lenses shall be engraved / embossed to clearly mark the following: **- Amendment 4**

a) Name or trade mark of the manufacturer.

b) Nominal diameter.

c) Nominal focal length ~~of the lenses.~~ **-Amendment 4**

~~d) Degree of horizontal spread of spreadlite lenses.~~
d) Degree of horizontal spread in case of spreadlite lenses **- Amendment 4**

e) Year of manufacture

f) Lot number **- Amendment 4**

4.1.1 A unique lot number shall be given to lenses and roundels of every lot. **- Amendment 4**

5. TESTS AND REQUIREMENTS

5.1 **Type Tests –** The following shall constitute type tests and shall be carried out in the sequence given below:

a)	Visual inspection	(Clause 5.4)
b)	Focal length of lenses.	(Clause 5.5)
c)	Colorometric tests.	(Clause 5.6)
d)	Effect of prolonged weather exposure on Colour Co-ordinates and transmittance	(Cl. 5.14) **-Amendment 2**
~~d)~~ e)	Alakalinity tests (Glass)	(Clause 5.7)
~~e)~~ f)	Measurement of horizontal spread of spreadlite Lenses. (Glass)	(Clause 5.9)
~~f)~~ g)	Chemical composition test for green and yellow outside stepped lenses for colour light signals (Glass)	(Clause 5.8)

Tests indicated at ~~(d)~~ (e) and ~~(f)~~ (g) above shall not be conducted on roundels and lenses made of polycarbonate material. In place of these tests, the following further tests shall be conducted on such roundels and lenses:

~~g)~~ h)	Raw material test.	(Appendix "D")
~~h)~~ i)	Hardness test.	(Clause 5.10)
~~i)~~ j)	UV Stabilization test	(Clause 5.11)
~~j)~~ k)	Annealing test	(Clause 5.12)
~~k)~~ l)	Izod impact strength test	(Clause 5.13)

5.1.1 A minimum of 3 lenses/roundels shall be tested for the above tests except alkalinity test. All samples shall successfully pass all the type tests for proving conformity with the requirements of this specification. If any of the sample fails in any of the type tests, the purchaser or his nominee, at his discretion, may call for fresh samples not exceeding twice the original number and subject them again to all tests or to the test(s) in which failure(s) occurred. No single failure shall be permitted in the repeat test(s). Only one lens/roundel shall be tested for alkalinity test. The lens/roundel shall not fail.

5.1.2 In addition to the tests indicated in the sub-clause 5.1.1, one green and yellow outside stepped lens for colour light signal shall be subjected to the chemical composition test as described in clause 5.8.

5.2 **Acceptance Tests** – The following shall constitute acceptance tests:

a)	Visual inspection	(Clause 5.4)
b)	Focal length of lenses	(Clause 5.5)
c)	Checking of transmittancy & colour	(Clause 5.6)
d)	Effect of prolonged weather exposure on colour co ordinates and transmittance	(Clause 5.14) **-Amendment 2**
~~d)~~ e)	Measurement of horizontal spread of spreadlite lenses.	(Clause 5.9)

The following further test shall be conducted on roundels and lenses made of polycarbonate material.

~~e)~~ f)	Hardness test	(Clause 5.10)
~~f)~~ g)	Specific gravity test	(Appendix 'D')
~~g)~~ h)	Annealing Test	(Clause 5.12)

5.2.1 ~~All roundels and lenses of red colour shall be tested for compliance with clause 5.6 for the remaining acceptance tests, sampling procedure given in Appendix "B" shall be adopted.~~

20**%** roundels and lenses of red colour shall be tested for compliance with clause 5.6. For remaining acceptance tests, sampling plan given in Appendix 'B' shall be followed. **–Amendment 4**

5.2.2 For roundels and lenses, other than red, sampling procedure given in Appendix 'B' shall be adopted for all the acceptance tests.

5.2.3 ~~The project roundels and lenses shall be rendered unusable in the presence of purchaser or his nominee.~~

In case roundels or lenses fail in any of effect of prolonged weather exposure on colour co-ordinates and transmittance, hardness and specific gravity tests during acceptance test, the entire lot should be destroyed in presence of inspecting officials. In case roundels or lenses fail in any other acceptance test, manufacturer will be allowed to segregate defective roundels/ lenses and reoffer the balance roundels/ lenses for inspection. Segregated defective roundels/ lenses should be destroyed before inspecting official and reoffered roundels/ lenses shall be inspected with double sampling. In case of double sampling, twice the N1

samples shall be tested with acceptance number C1 as per Table B of Appendix 'B' and there shall not be second sample. If roundels/ lenses fail in double sampling, the entire lot shall be destroyed before inspecting official.

–Amendment 4

5.2.4 In case roundels and lenses manufactured in a 'lot' are offered for inspection in more than one smaller lots, test for effect of prolonged weather exposure on colour co-ordinates and transmittance once carried out may not be conducted on subsequent offers provided proper traceability to the 'lot' is maintained by the manufacturer. Rest acceptance tests shall be carried out.

–Amendment 4

5.3 **Routine Tests** – The following shall, constitute routine tests. The manufacturer shall certify that the routine tests have been carried out on the lots offered for inspection:

a) Visual inspection (Clause 5.4)

b) Checking of transmittancy and colour (Clause 5.6)

c) Alkalinity test (Clause 5.7) **-Amendment 4**

d) Chemical composition (Clause 5.8) **-Amendment 4**

5.3.1 Visual inspection shall be carried out on 100% roundels and lenses. Transmittance and colour co- ordinates shall be checked on minimum 20% of every lot except for red roundels and lenses. Red roundels and lenses shall be checked for 100% lot. **–Amendment 4**

5.3.2 Alkalinity and chemical composition shall be tested on minimum three samples of every lot. **–Amendment 4**

5.3.3 Test record shall be properly maintained with traceability to lot / samples tested, which may be verified by inspecting officials. **–Amendment 4**

5.4 **Visual inspection** – The roundels and lenses shall be visually inspected for compliance with clause 3.1, 3.6 and 3.10.

5.5 **Focal length of lenses-**

5.5.1 The focal length of a lens shall be determined by mounting it in front of an approved point source of light capable of being moved along the axis of the lens. The beam emerging from the lens shall be viewed in a mirror placed at a minimum distance of 15 metres from the lens. The light source shall be moved along the axis of the lens in such a manner that a uniform bright flash of light is observed in the mirror. The axial distance between the plane of seating of the lens and the light source shall then be accurately measured.

5.5.2 The doublet combination of lenses, outside stepped inner lens and inside stepped outer lens shall be mounted in front of an approved point source of light capable of being moved along the axis of the lenses. The beam emerging from the combination of lenses shall be viewed in a mirror placed at a minimum distance of 15 metres from the lenses. The light source shall be moved along the axis of the lenses in such a manner that a uniform bright flash of light is observed in the mirror. The axial distance between the plane of the seating of the inner outside stepped lens and the light source shall then be accurately measured.

5.5.3 The lens or combination of lenses shall comply with the requirements specified in clauses 3.8 and 3.11.

Note- SL-5 lamp is considered adequate and suitable as a point source of light for the purpose of this specification.

5.6 **Colorometric Tests** ~~— Measurement of colour and transmittancy of roundels and lenses shall be carried out in accordance with BS: 1376 and shall comply with the requirements specified therein. The transmittance value of clear polycarbonate lenses shall not be less than 88%.~~

Measurement of colour and transmittance of roundels & lenses shall be carried out in accordance with BS : 1376 except that the transmittance of polycarbonate roundels and lenses shall be carried out as per ASTM: D 1003 and shall comply with the requirements specified therein. The transmittance value of clear polycarbonate lenses shall not be less than 84% when checked on central portion of finished product.

-Amendment 2

5.7 **Alkalinity Test** - The roundels and lenses made of glass shall conform to at least Grade Type 4 of IS: 2303 i.e. Titre Value not exceeding 3.

5.8 The chemical composition of green and yellow lenses made of glass material for colour light signals shall be determined in accordance with ASTM: C169 and shall comply with the following:

~~**Constituent**~~	~~**Chemical composition**~~	
	~~**Green lens**~~	~~**Yellow lens**~~
~~SiO_2~~	~~70.20%~~	~~74.64%~~
~~Al_2O_3~~	~~0.81%~~	~~1.71%~~
~~Fe_2O_3~~	~~0.30%~~	~~0.14%~~
~~Ca O~~	~~6.16%~~	~~4.69%~~

~~Mg O~~	~~0.20%~~	~~0.26%~~
~~K_2 0~~	~~1.62%~~	~~0.68%~~
~~Na_2 0~~	~~17.64%~~	~~16.30%~~
~~B_2 0_3~~	~~1.83%~~	~~1.32%~~
~~Cr_2 0_3~~	~~0.16%~~	~~--~~
~~Cu 0~~	~~0.88%~~	~~--~~
~~Ti 0_2~~	~~Traces~~	~~Traces~~
~~Zn 0~~	~~--~~	~~0.025%~~

Sl. No.	**Constituent**	**Chemical Composition**		Tolerance
		Green Lens	**Yellow Lens**	
i.	SiO_2	70.20 %	74.64 %	± 10 %
ii.	Al_2O_3	0.81 %	1.71 %	± 10 %
iii.	Fe_2O_3	0.30 %	0.14 %	± 10 %
iv.	CaO	6.16 %	4.69 %	± 10 %
v.	MgO	0.20 %	0.26 %	± 10 %
vi.	K_2O	1.62 %	0.68 %	+ 0 % , - 5 %
vii.	Na_2O	17.64 %	16.30 %	+ 0 % , - 5 %
viii.	B_2O_3	1.83 %	1.32 %	± 10 %
ix.	Cr_2O_3	0.16 %	-	± 10 %
x.	CuO	0.88 %	-	± 10 %
xi.	TiO_2	Traces	Traces	± 10 %
xii.	ZnO	-	0.025 %	± 10 %

-Amendment 4

5.9 Measurement of horizontal spread of spreadlite lenses- The angle of horizontal spread of spread of spreadlite lenses shall be measured with a method mutually agreed upon between the manufacturer and purchaser or his nominee to check conformity with the requirement of clause 3.9. Any spread measurement will, however, not be made at less than 5 metres away from the lens.

5.10 **Rockwell Hardness test-**

The samples selected for type tests shall be subjected to Rockwell hardness test as per test method laid down in ASTM: D 785 and the hardness value thus obtained shall not be less than 95.

5.11 **UV Stabilization test-**

The test procedure to be followed for conducting this test is given below:

(a) A solution of Polycarbonate in Methylene Dichloride (spectrophotometric grade) maintaining a concentration of Lexan in solution slightly higher than 1%.

(b) The solution shall then be filtered to remove all suspended particles.

(c) The precise concentration of the solution shall be measured.

(d) The volume shall be made up to achieve exact 1% solution.

(e) A double beam U.V. spectrophotometer shall be arranged.

(f) One spectrophotometer cell shall be filled up with the solution and the other with the solvent.

(g) Scanning shall then be done over a wavelength range of 300 to 400 nm.

(h) A sharp peak at 343 nm shall indicate presence of the specified UV stabilizer in the material. There could be another peak nearby which should be ignored.

5.12 **Annealing Test-**

To ensure that the annealing has been properly done, the annealed polycarbonate roundels and lenses shall be tested as follows:

a) The sample shall be immersed completely for 15 secs. In carbon tetra-chloride.
b) The sample shall then be removed and allowed to dry for 3 to 5 minutes at room temperature.
c) The samples after drying shall be visually examined and there shall be no crack apparent. In case any crack is found on visual examination, the samples shall be re-annealed.

5.13 **Izod Impact Strength Test-**
Izod impact strength test shall be conducted in accordance with the method given in ASTM:D 256 and the value obtained shall be min. 600 J/m. The specimen for this test shall conform to Fig.2.

5.14 **Effect of prolonged weather exposure on colour co-ordinates and transmittance-** The colour co-ordinates of coloured lenses/roundels and transmittance of clear lenses/roundels shall be checked.

Then these samples shall be subjected to light and water exposure for total 300 hrs. at cycle rate: 4 hrs. UV at 60 deg.C and 4 hrs. condensation at 50 deg.C as per procedure laid in ASTM: G 53. The change in the colour co-ordinates/transmittance after this test shall not be more than +/- 2%.

-Amendment 2

This test shall be conducted on three samples of each colour in case of type test as well as acceptance test, irrespective of the lot size.

-Amendment 3

6.0 PACKING

6.1 Each roundel or lens shall be wrapped with a piece of paper of corresponding colour and shall then be packed in suitable packing cases, the cases being marked "HANDLE with CARE" on all sides. The roundels and lenses of different sizes, types and colours shall be kept distinct when packed.

6.2 The packing shall be such as to permit convenient handling and to protect against loss or damage during transit and storage.

6.3 Manufacturer shall be responsible for safe transportation of roundels and lenses. These should be delivered in good condition to consignee at his depot. If there is any damage, manufacturer shall replace that free of cost.

-Amendment 4

TABLE 1
(a) -Roundels

Diameter (mm)	Colour	Use
38	Red, yellow & green	Signal repeaters Luminous
89	Red, yellow & green	Miniature semaphore & disc. Signals
213	Red, yellow & green	UQ signals, LQ signals
245	Red, yellow & green	LQ signals.

TABLE 1(b) -Lenses

Diameter (mm)	Nominal Focal length (mm)	Type	Colour	Use
92	16 *	Outside step	Lunar white	Route indicator, Direction type
101	89	Inside step	Red, Green Lunar white and clear	Point/trap indicators, target type, Shunt signal, Position light type (clear only)
127	70	Inside step with moulded prism for close up indication.	Clear	Route indicators, Direction type
136	89	Inside step	Red, yellow, green & clear.	Hand and temporary Engineering signal lamps, Semaphore signal lamps(Clear only)
136	89	Inside step, Spreadlite	Clear	Semaphore signal lamps.
140	13#	Outside step	Red, yellow & green	Colour light signals multi-unit type.
213	102	Inside step, spreadlite	Clear	Colour light signals multi-unit type.
213	102	Inside step with moulded prism for close-up indication	Clear	~~Colourlight Signals multi-unit type (for stop signals only)~~ Colour light signals, multi-unit type (for red aspect only) **-Amendment 1**
213**	102	Inside step without moulded prism for close-up indication	Clear	~~Colourlight signals, multi-unit type (for permissive signals only)~~ Colour light signals, multi-unit type (for other than red aspects) **-Amendment 1**

* The focal length refers to doublet combination of the lens with 127mm dia x 70 mm focal length inside step clear lens.

\# The focal length refers to doublet combination of the lens with 213 mm dia x 102 mm focal length inside step clear lens.

** The inside step clear lens, moulded out of polycarbonate material, shall confirm to Drg No. S 24845.

APPENDIX 'A'
(Clause 3.2)

INFORMATION TO BE FURNISHED BY THE PURCHASER

A-1 Roundels or lenses.

A-2 Diameter

A-3 Colour

A-4 Nominal focal length of lenses.

A-5 Type of lenses viz. Outside step, inside step, spreadlite.

A-6 Drawing number.

APPENDIX 'B'
(Clause 5.2)

SAMPLING FOR ACCEPTANCE OF LOTS

B-1 **Lot**

B-1.1 ~~In any consignment, all the roundels or lenses of the same type manufactured by the same factory during the same period shall be grouped together to constitute a lot.~~

Lot is a collection of roundels or lenses of one type, size and lot number manufactured by same process under similar conditions of production. In case roundels or lenses manufactured in a lot are offered for inspection in more than one smaller lots, sampling plan for acceptance test may be adopted as per offered quantity and relevant provision of specification for every such smaller lot.

-Amendment 4

B-1.2 From each lot a certain number of roundels or lenses shall be selected at random and subjected to the relevant acceptance tests. Any roundels or lens failing to satisfy the appropriate requirements shall be considered as defective.

B-2 **CRITERION FOR CONFORMITY**

B-2.1 The actual number of roundels or lenses to be selected from a lot shall be in accordance with Table B, where N1 is the size of the first sample. If the number of defectives found in this sample is less than or equal to C1, the lot shall be considered as conforming to the requirements of this specification. If the number of defectives is equal to or greater than C2, the lot shall be considered as not conforming to the requirements of this specification. If the number of defectives in the first sample lies between C1 and C2, a further sample of N2 roundels or lenses shall be taken and tested. If the number of defectives in the two samples combined is less than C2, the lot shall be considered as conforming to the requirements of this specification, otherwise the lot shall be considered as not conforming to the requirements of this specification.

TABLE B- SAMPLING PLAN

Lot/Size	First Sample	Second sample	N1+N2	Acceptance number	Rejection number
	N1	N2		C1	C2
Upto 100	3	6	9	0	2
101-200	4	8	12	0	2
201- 500	7	14	21	0	3
501-800	10	20	30	0	3
801-1300	13	26	39	0	5
1301-3200	20	40	60	1	5
3201-8000	25	50	75	1	6
8001-22000	35	70	105	2	7

APPENDIX-'C' - 1

Table 1 of BS 1376:1974

Limits for signal colours. Boundary equation in terms of CIE (1931) chromaticity co- ordinates-

Colour Name	Colour Class	Boundary towards blue	Boundary towards green	Boundary towards yellow	Boundary towards red	Boundary * towards purple	Boundary towards white
Signal Red	A B C	- - -	- - -	y = 0.335 y = 0.320 y = 0.300	- y = 0.300 -	y = 0.980 – x y = 0.990 – x y = 0.995 - x	- - -
Signal yellow	A B C	- - -	y = x - 0.120 y = x - 0.120 y = x - 0.160	- - -	y = 0.382 y = x - 0.170 y = 0.382	- - -	y = 0.790 – 0.667x y = 0.790 – 0.667x y = 0.790 – 0.667x
Signal Green	A B C	y = 0.390 – 0.171x y = 0.390 – 0.080x y = 0.390 – 0.080x	- - -	x = 0.390 – 0.171y x = 0.520 – 0.500y y = 0.600 – 0.434x	- - -	- - -	x = 0.650y x = 0.650y – 0.030 x = 0.625y – 0.041
Signal Blue	A	-	y = 0.065 + 0.805x	-	-	x = 0.133 + 0.600y	y = 0.400 - x
Signal White $	A B C	x = 0.285 - x = 0.285 - x = 0.285	y = 0.150 + 0.640x - y = 0.150 + 0.640x - y = 0.150 + 0.640x	y = 0.640 – 0.400x x = 0.540 y = 0.640 – 0.400x x = 0.500 x = 0.440	y = 0.390 - y = 0.390 - -	y = 0.050 + 0.750x - y = 0.050 + 0.750x - y = 0.050 + 0.750x	- - - - -

* Not to be confused with the 'purple boundary' joining the extremes of the spectrum locus which is marked separately on figure 1 of BS: 1376.

$ There is a risk of yellowish whites being confused with a yellow signal. Whites with an x co-ordinate greater than 0.500 can not be reliably recognised as white and their use is deprecated.

APPENDIX-'C' - 2

Table 2 of BS 1376:1974

Typical applications of colour classes for light signals

Colour (Application)	**Red** (Class)	**Yellow** (Class)	**Green** (Class)	**Blue** (Class)	**White** (Class)
Aircraft	A	B	A	A	B
Airfields (Gen.)	A	B	A	A	B
Airfields (High recognition)	C	B	B	A	B
Light houses	A	A	A	A	A
Railway signals (Day colour lights)	C *	B	C	-	C #
Railway Signals (Semaphore)	C	C	C	-	-
Road traffic light	B	A	C	-	-
Ships lights	B+C	-	B	-	A

* Restricted to y not greater than 0.295 for high intensity red signals.

\# Restricted to between X = 0.330 and 0.420 and known as 'Lunar White.'

APPENDIX-'C' - 3

Table 5 of BS 1376:1974

Minimum filter transmittancy (in percentage) when measured with standard illuminant A

Colour name	Colour Class	Colour temp. Range of design light source		
		1900 K-2200 K	2200 K-2500 K	2500 K-3300 K
		%	%	%
Signal Red	A	7	7	7
	A/HT	18	18	18
	B	10	10	10
	C	7	7	7
Signal Yellow	A	45	40	30
	A/HT	65	60	50
	B	65	60	50
	C	45	40	30
Signal Green	A	9	9	9
	A/HT	15	20	20
	B	9	9	9
	C	9	9	9
Signal white	C *	25	25	25

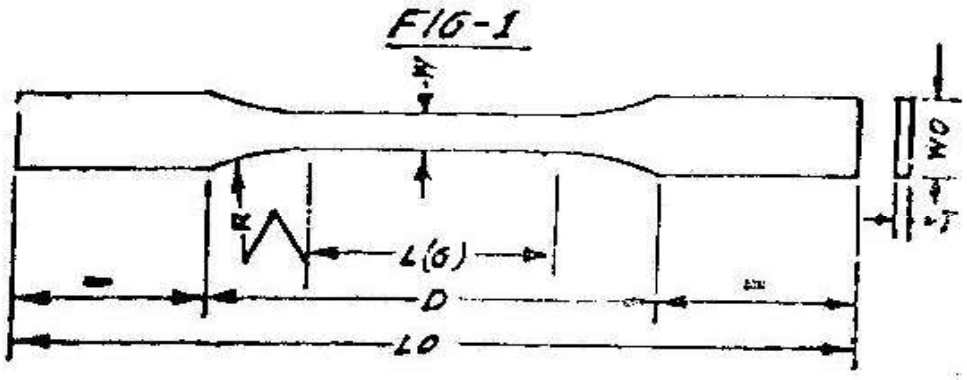
* 'Lunar white' for railway use

APPENDIX 'D'

S.No.	Properties	Value for poly carbonate material	Method of test
1	Tensile strength at Yield (kg/Sq.mm) min	5.8	ASTM: D 638
2	Elongation at break (%) min.	90	ASTM: D 638
3	Specific gravity	1.18-1.22	ASTM: D 792

Note: The specimen for these tests shall conform to Fig. 1.

SPECIMEN FOR TENSILE TEST FOR POLYCARBONATE COMPONENTS-



DIMENSIONS FOR TEST SPECIMEN

DESIGNATION	DIMENSIONS	TOLERANCE
W- Width of narrow section	10	± 0.5
L (G) Length of narrow section (Also Gauge length)	60	± 0.5
WO- Width overall	20	± 0.5
LO- Length overall	216	± 0.5
D - Distance between grips	115	± 0.5
R - Radius of filet	60	± 0.5
T - Thickness	3.5	± 0.5

Note:-

4 The specimen shall be free of draft or fin.
3. Speed of testing shall be 5 mm / min.
2. Minimum area of cross section within gauge length shall be adopted for calculation of tensile strength.
1. All dimensions in millimeters.

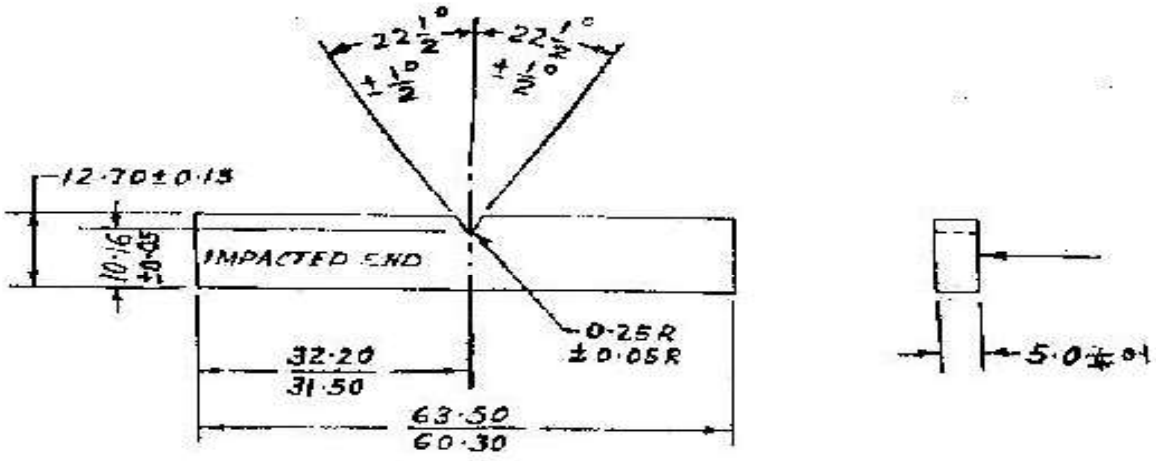


Fig.2

DIMENSIONS OF IZOD TYPE TEST SPECIMEN

1. All dimensions in Millimeters
2. Arrow marked thus (X) shows direction of compression moulding

In Fig. 2, thickness of Izod type test specimen may be changed from 5.0 ± 1.0 to 3.0 ± 0.5.

-Amendment 2
