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TECHNICAL REPORT

RECOMMENDATIONS FOR SURFACE COLOURS FOR VISUAL SIGNALLING

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Ces recommandations ont été préparées par le Comité Technique 1.6 Signalisation Visuelle. Elles ont été approuvées par au moins 80 % des Comités Nationaux des Pays Membres de la CIE comme base valable pour les Spécifications et Codes de Bonne Pratique nationaux et internationaux. Il faut toutefois noter que ces recommandations sont données à titre de conseil et non d'obligation. En ce qui concerne la situation présente de ces recommandations et d'éventuelles modifications ultérieures, il y a lieu de consulter le plus récent compte rendu de Session ou le Journal de la CIE.

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SUMMARY

The object of the present recommendations is to provide a system of surface colours for the purpose of visual signalling. The colours are defined in terms of chromaticity limits and limits of luminance factor, and these limits have been chosen as a compromise between reliable colour recognition, existing practice that has proved to be satisfactory, and the limitations imposed both by manufacturing technology and by the uncertainties of colour measurements.

The limits are recommended for international adoption; more restricted limits may be selected by national authorities to suit national practices or by international authorities to suit particular applications.

The recommendations apply to all surface colours, whether produced by reflection, fluorescence or transillumination, which are intended for the visual signalling of any form of transport, and also for warning signs and colour codes in general.

RÉSUMÉ

L'objet des présentes recommandations est d'établir un système de couleurs de surface pour application en signalisation visuelle. Les couleurs sont définies en termes de limites de chromaticité et limites de facteur de luminance, et ces limites ont été choisies par compromis entre une reconnaissance sûre de la couleur, les pratiques établies qui ne sont révélées satisfaisantes et les limitations imposées par la technologie industrielle et par les incertitudes des mesures de couleur.

Les limites sont recommandées pour l'adoption internationale; des limites plus restreintes peuvent être choisies par les autorités nationales pour s'adapter aux pratiques nationales ou par les autorités internationales en fonction d'applications particulières.

Les recommandations s'appliquent à toutes les couleurs de surface, qu'elles soient produites par réflexion, par fluorescence ou par transparence, qui sont destinées à la signalisation visuelle pour tous moyens de transports et aussi pour les signaux d'avertissement et pour les codes de couleur en général.

ZUSAMMENFASSUNG

Die vorliegenden Empfehlungen geben ein System von Aufsichtsfarben zur visuellen Signalgebung an. Die Farben werden durch Farbgrenzen und Grenzwerte der Leuchtdichtefaktoren definiert. Diese Grenzen stellen einen Kompromiß dar zwischen zuverlässiger Farberkennung und bestehender bewährter Praxis sowie Einschränkungen, die sich durch Herstellungstechniken und Unsicherheiten der Farbmessungen ergeben.

Die Grenzen werden zur internationalen Annahme empfohlen; dabei können engere Grenzen gewählt werden, von den nationalen Signaldiensten, um nationalen Anforderungen gerecht zu werden, oder von internationalen Signaldiensten, um besondere Anwendungsfälle zu verwirklichen.

Die Empfehlungen gelten für alle Aufsichtsfarben, die durch Reflexion, Fluoreszenz, Retroreflexion oder Innenbeleuchtung entstehen und der visuellen Signalgebung für alle Verkehrsarten, für Warnschilder und allgemeine Farbcodes dienen.

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SURFACE COLOURS FOR VISUAL SIGNALLING

FOREWORD

Transport by land, sea and air is international, and the colours of the signs used for its guidance or control are a matter of international importance. The present recommendations describe a system on which uniform practice can be based to ensure reliable recognition of the surface colours used on signs, but within which local variations are possible in order to suit the type of transport service or to provide conformity with established national practice.

The first proposals for a system of surface colours were presented to the CIE Session in Vienna in 1963 by Committee E.1.3.3. : Signal Colours. Consideration of the subject continued in the subsequent years, until in 1971, the committee, now redesignated as Committee TC-1.6 : Visual Signalling, appointed a sub-committee to prepare recommendations. A Technical Report, which provided a basis for the present Official Recommendations, was accepted at the CIE Session in London in 1975 and published in 1978 as CIE Publication No. 39. In the present document, developments since 1975 are taken into account and therefore the text and recommendations differ in many parts from what was in the Technical Report. Furthermore, high-conspicuity colours are no longer included but comprehensive recommendations are now given for the colours of transilluminated signs.

1. INTRODUCTION

Transport by land, sea and air is international. Coloured signal lights and coloured signs are used to ensure the proper guidance and control of the various forms of transport, so as to increase safety and to facilitate rapid movement.

In order to avoid the confusion which might be caused by the use of a multiplicity of different signalling systems (resulting from differences between national regulations or between regulations applying to particular forms of transport), it is necessary that recommendations should be made at international level concerning the colours to be used for visual signalling, and that colour limits (see Section 2.2) should be defined for each colour recommended.

Recommendations have already been published by the CIE for the colours of light signals, for international uses [CIE Publication No. 2/2 (1975) Colors of Light Signals]. It is the purpose of the following recommendations to provide a similar guide for the choice of surface colours and to specify the required colour limits for these, in order to ensure maximum probability of recognition of colour and code. The recommendations apply to all signs which are intended for the visual signalling for any form of transport, and to warning signs and colour codes in general. Colour limits are recommended for the ordinary colours of surfaces, but special consideration is also given to fluorescent colours, to the colours of retro-reflecting materials, and to the colours of transilluminated signs.

The recommendations are based in part on experiments conducted under a variety of conditions [Blaise 1971, Jainski 1960, 1976, 1977, 1978] and in part on the limitations imposed by manufacturing technology and uncertainties of colour measurements. In drawing up the recommendations, the responsible committee, TC-1.6, has furthermore considered a number of other recommendations and standards that have been published nationally or internationally [BS 1973, DIN 1979, ISO 1979, NNI 1966].

In accordance with CIE practice, the colours and colour limits have the status of recommendations. It is intended that each authority, national or international, responsible for a signalling service should draw up its own mandatory regulations within the limits defined by these recommendations, as may be appropriate to the particular requirements of that authority.

Sometimes colours are used as background colours in applications where the colours themselves have little or no meaning, for example, some motor vehicle licence plates. These backgrounds may be described by colour names, but the colour limits recommended in this document are not applicable to them.

2. GENERAL

2.1. TYPES OF SURFACE COLOURS

2.1.1. Ordinary Colours

The ordinary colour of the surface of a material is produced as a result of the selective absorption of light incident upon the surface. The colour perceived is dependent on a complexity of factors, which includes the spectral distribution of the incident light, the spectral radiance factor of the surface, and several visual parameters such as the state of adaptation of the observer and the colour of the surrounding areas. However, in order to define colour for practical purposes, it is sufficient to use the chromaticity coordinates of the CIE 1931 Standard Colorimetric System and the luminance factor. These quantities are dependent only on the spectral distribution of the incident light and the spectral luminance factor of the surface.

In considering the ordinary colour of a surface, it is usual to assume that the surface is a uniformly reflecting diffuser. The light reflected from a glossy or semi-glossy surface includes some specular reflection, which should usually be excluded when defining the colour, and the geometry of measurement recommended in this document is one that will exclude such reflection.

2.1.2. Fluorescent Colours

The recommendations for fluorescent colours are for those colour materials which are sometimes called daylight fluorescent colours. These materials are paints, pigments or dyes which exhibit photoluminescence as the result of exposure to daylight. They absorb energy from daylight in the shorter wave-length regions of the visible spectrum and/or in the ultra-violet region and re-radiate some of this energy at longer wave-lengths, producing narrow bands of emission in the visible region. The phenomenon can considerably increase the luminance factors, and usually also the purities, of fluorescent colours relative to the values obtainable for ordinary colours, and it is most effective for red, orange and yellow. For yellow, luminance factors exceeding unity may be obtained.

2.1.3. Retro-reflecting Materials

Retro-reflecting materials differ from ordinary materials in that the light reflected from them is mainly returned in directions close to the direction from which it came. This property is maintained over wide variations of the direction of the incident light. Under diffuse incident light, e.g. daylight, the luminance factor is usually less than that obtained for corresponding ordinary colours, but may be sufficient to permit colour recognition.

The colour may be introduced in various ways within the material, or by coating or printing with transparent colours on the surface of the material.

The colour perceived is not only dependent on the spectral distribution of the incident light but may, more than ordinary colours, be influenced by the direction at which the light is incident and the direction from which it is observed.

2.1.4. Transilluminated Signs

Transilluminated signs are used where a sign is required to be visible both by day and by night and where an artificial light source can be provided. The materials used for the surfaces of transilluminated signs exhibit properties partially of transmission and partially of diffuse reflection. By day they are commonly seen by reflected daylight; but they may also be illuminated artificially by transmitted light, so as to make them visible by night or to enhance their visibility under poor daylight conditions.

The colour perceived is dependent on the colour of the illuminant under the conditions of observation. In addition, particularly in the case of internally coloured materials, there may be differences in colour depending on whether the light is transmitted or reflected.

2.2. THE SPECIFICATION OF SURFACE COLOURS

In these recommendations, the colour of a surface is specified by chromaticity coordinates in the CIE 1931 Standard Colorimetric System, together with the luminance factor (but there is an exception for the transmitted light of transilluminated signs, for which the relative luminance with respect to white, in percentage, is used). For further information on this method of specification see CIE Publication No 15 (1971) Colorimetry.

The specification of a surface colour differs from that of the colour of a light, which can generally be adequately described by chromaticity coordinates alone. Since surface colours are not in general perceived in isolation, but in relation to other colours on a sign or in the natural surroundings, the luminance factor is as much a part of the specification of the colour as is the chromaticity.

In this document, the term colour limits is used to mean the limits of a recommended region on the chromaticity diagram, within which the specified colour may fall, together with the limit (or limits) of an associated luminance factor.

The recommended limits for the chromaticity coordinates of each surface colour are shown by straight lines in the CIE chromaticity diagrams in Figures 1, 2, 3 and 4. The equations of these lines, or boundaries, which define the limits, are shown in Tables 1, 3, 5, 8A and 8B. For convenience in reproducing the limits in graphical form, the coordinates of the points of intersection of the lines with one another, and with the spectrum locus or the purple boundary, are given to three places of decimals in Tables 2, 4, 6 and 9.

The recommended limits for the luminance factor of each surface colour are also given in Tables 1, 3, 5 and 8A. There are minimum values for the colours red, orange, yellow, green, blue, purple and white; there is a maximum value for black; and there are both maximum and minimum values for grey and brown.

In order to ensure uniformity of application of the recommendations, it is necessary to specify the conditions of illumination and viewing for which the colour limits are defined. These conditions cannot represent all practical conditions, but they have been chosen to ensure relative simplicity of measurement while remaining as representative as possible of most practical conditions. In the recommendations, all colour limits have been specified for illumination by CIE Standard Illuminant D_{65} and for CIE recommended geometry 45°/normal (abbreviation, 45/0) (namely, illumination at 45° and measurement of the reflected light normally), and are thus defined for an approximation to the conditions of daytime observation, see CIE Publication No 15 (1971) Colorimetry.

The recommended colour limits are intended to apply throughout the useful service life of a sign, and it is clearly desirable that the sign should be renewed when its colours cease to conform with the recommendations.

For the night-time chromaticity of retro-reflecting materials, no precise specification can be given at present. In night-time use, the surfaces are illuminated and viewed at nearly the same direction. It has been found that significant variations in chromaticity may occur for small changes in viewing geometry, and, even for a specified geometry, significant differences of measured chromaticity have been found in the comparison of results obtained by different laboratories internationally. Mainly because of these problems of measurement, there are at the moment practical difficulties in realizing a precise night-time colour specification. This subject is currently under investigation.

The colours of a transilluminated sign must be specified for two different conditions of illumination, namely, while being illuminated by transmitted light and while not being illuminated by transmitted light. Under the latter condition, the colours can be considered as ordinary colours. Under the former condition, chromaticity coordinates can be used to specify the colours, but luminance factors are inapplicable and must be replaced by relative luminances, which are defined in this document by the ratios of the luminances of the colours to a white part, whether real or assumed, on the sign. The recommended limits for the relative luminance of each surface colour are given in Table 8B.

2.3. THE USE OF SURFACE COLOURS

In any system of visual signalling which makes use of surface colours, the number of colours should be kept to a minimum.