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Australian Standard 2633—1983

GUIDE TO THE SPECIFICATION OF COLOURS

STANDARDS ASSOCIATION OF AUSTRALIA
Incorporated by Royal Charter

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This Australian standard was prepared by Committee LG/—, Lighting Standards. It was approved on behalf of the Council of the Standards Association of Australia on 3 May 1983 and published on 4 July 1983.

The following interests are represented on Committee LG/—:

Australian Electrical and Electronic Manufacturers Association

Australian National Committee on Illumination

Australian Optometrical Association

Australian Road Research Board

CSIRO, Division of Applied Physics

Confederation of Australian Industry

Department of Employment and Industrial Relations

Department of Housing and Construction

Department of Public Works, N.S.W.

Electricity Supply Association of Australia

Illuminating Engineering Societies of Australia

University of New South Wales, Department of Transport Engineering

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GA
26514
ASTAN AA26514
ASTAN AA33877

ATT: ELEANOR ETHEL - SIC

RE: CIE 1931 CHROMATICITY DIAGRAM

UNFORTUNATELY WE DON'T HAVE THIS. IAN WILSON DOES NOT THINK THAT CIE REPRODUCES IT IN COLOUR - APPARENTLY THERE IS SOME TECHNICAL DIFFICULTY IN REPRODUCING IT IN COLOUR. IAN SUGGESTS THAT THE IES LIGHTING HANDBOOK OR SIMILAR TEXTBOOKS MAY HAVE SOMETHING IN THEM. SORRY WE CAN'T HELP.

REGARDS
RAE RAPHAEL - MIC
1985-04-15-1220
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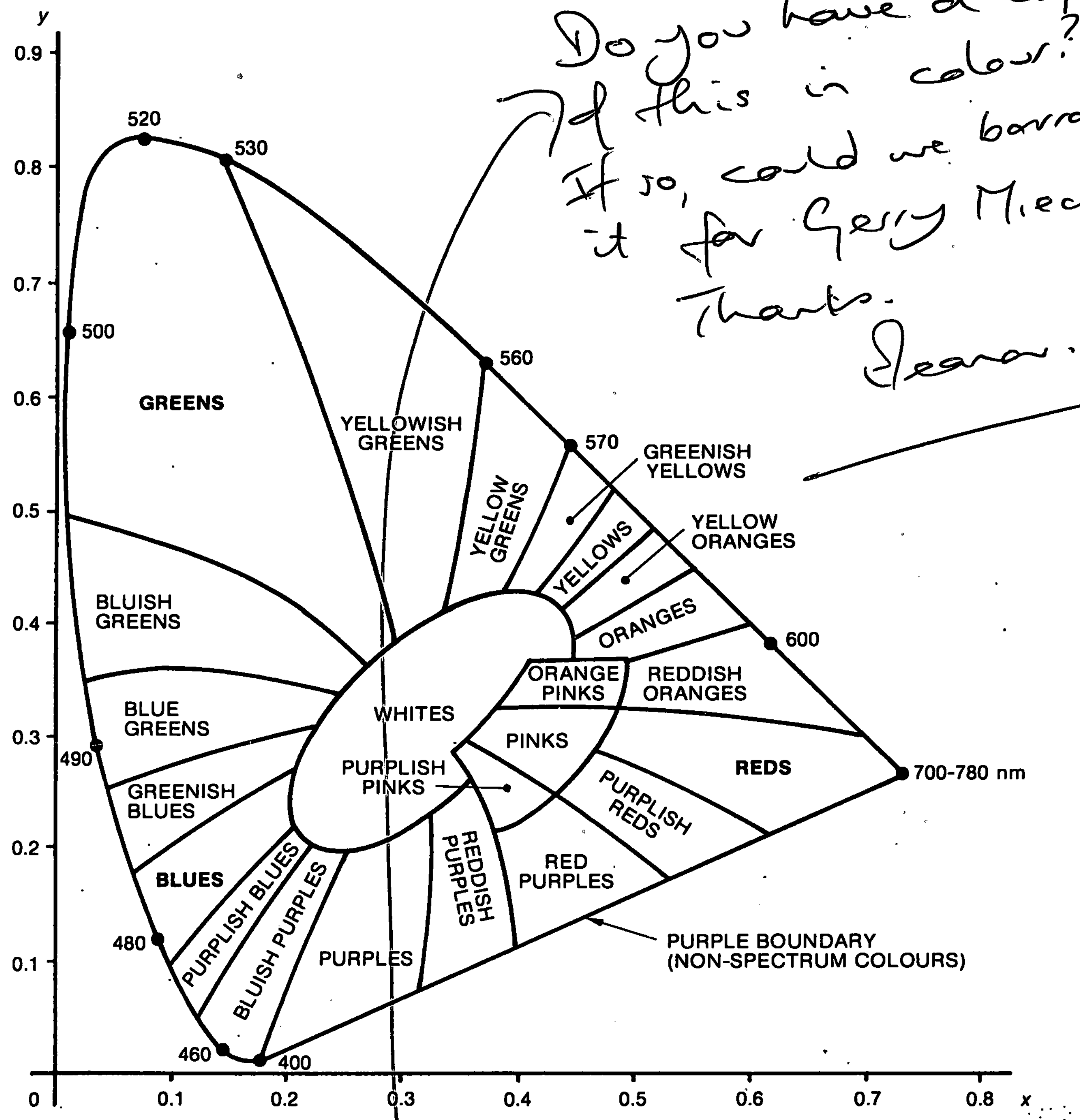
ASTAN AA26514
ASTAN AA33877

Rae. 11/4/85

Do you have a copy of this in colour? If so, could we borrow it for Gerry Mitchell?
Thanks.
Eleanor.



NOTES:

1. The curvilinear locus represents the chromaticity of the spectral colours from a wavelength of 380 nm (purplish blue) to 780 nm (red). This locus, together with the straight line representing the boundary of the purples, encloses the domain of real colours.
2. The boundaries between different regions of colour are illustrative only; the transition between adjacent colours will be gradual and not sharply delineated as shown in the diagram.

Fig. 3.1. THE CIE 1931 CHROMATICITY DIAGRAM

Wrote
Don't think CIE
even reproduce
in colour – difficult
to reproduce
IES lighting handbk [very expensive]
Textbooks

Some of texts mentioned

system, so that the colours corresponding to the notation can be visualized (Refs 16, 19).

There are also tables and graphs which enable a given Munsell notation to be converted to the CIE colorimetric system (Ref. 18). The NBS 'Universal Color Language' (Ref. 17) can be used to give names to Munsell colours.

A standard procedure for the specification of colours by the Munsell system is given in ASTM D 1535 (Ref. 15).

3.4 CIE COLORIMETRIC SYSTEM. The CIE approach to colour specification allows the finest subdivision of colour space, and it has been estimated (Ref. 17) that it provides for the specification of about 5 000 000 identifiable colours. It therefore lends itself to precise specification of tolerances.

The basic system is the CIE 1931 standard colormetric observer, but there are several variants which are appropriate for particular applications. The variants of the CIE system are set out in Table 3.1.

The CIE 1931 standard observer will be the system most commonly used in Australian standards and is the preferred system unless there are sound technical reasons for adopting one of the other systems. The CIE 1964 standard observer should be used for large fields and occasionally it may be desirable to present the specification in a uniform chromaticity scale diagram to illustrate the real perceptual differences between colours. In this case, the CIE 1976 u' v' diagram is appropriate. The CIELUV and CIELAB systems will be used only for sophisticated colour measurement by industrial groups concerned with colourant mixtures.

Because colour has three dimensions, the CIE system specifies colour by three numerical values. Two of the values (x, y in the 1931 system) specify the colour of the sample and the third (Y) specifies the luminous reflectance or luminous transmittance. The CIE 1931 chromaticity diagram displays the two chromatic variables (x, y) and is illustrated in Fig. 3.1.

The numerical values for colour in the CIE system can be obtained in either of the following ways:

(a) *Spectrophotometric measurement.* The spectrophotometric method is the most accurate and versatile procedure and is usually preferred since spectrophotometers are a common laboratory instrument. The spectral reflectance or transmittance of the sample is measured by spectrophotometry and the three numerical values (x, y, Y) are then calculated with respect to a standard illuminant (or several standard illuminants) and either or both standard observers using tables provided by the CIE (Ref. 3).

(b) *Use of a tricolorimeter.* A tricolorimeter is an instrument that has a photosensor and three colour filters, or three photosensors each with its own colour filter, to make a direct reading of the numerical values of colour. A tricolorimeter may be the preferred method for field measurements where the sample to be measured cannot be accommodated in a spectrophotometer.

Because the CIE system is numerical, colour limits can be expressed quite rigorously by algebraic expression and can be illustrated graphically.

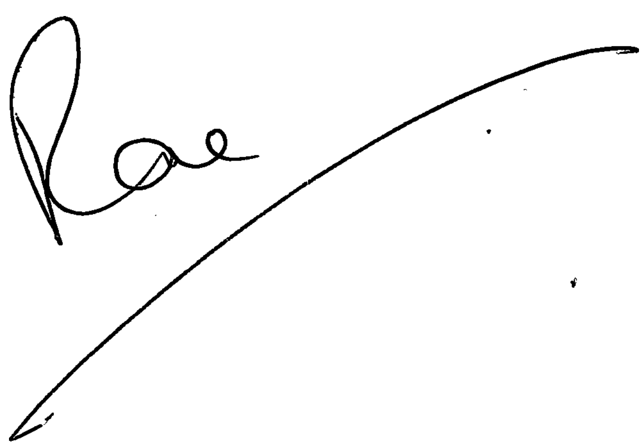
Appendix A gives an example of the specification of the permitted domains of colours using the CIE 1931 system. In Appendix A, the permitted chromatic limits are specified by the table and are illustrated by the graph. The boundaries of the permitted colour domains could have been described by simple linear equations, although giving the coordinates of the corners of permitted colour domain is usually a clearer method of specification. The third variable Y is not specified in Appendix A. This is the luminosity variable and for signal lights it is specified separately by defining the minimum luminous intensities emitted. For a coloured surface, it would be necessary to give the minimum and maximum values of Y to define the permitted range of luminous reflectance.

The outstanding advantage of the CIE system is that it is international and recognized by the major international institutions concerned with standardization. This does not apply to any other method of colour specification.

TABLE 3.1

CIE COLORIMETRIC SYSTEM

Designation	Application
CIE 1931 Standard Colorimetric Observer	For colours that subtend between 1 degree and 4 degrees at the observer's eye
CIE 1964 Supplementary Standard Colorimetric Observer	For colours that subtend more than 4 degrees at the observer's eye
CIE 1960 Uniform Chromaticity Scale *Abbreviation:* CIE 1960 u v diagram	A linear projective transformation of either the 1931 standard observer or the 1964 standard observer to provide a chromaticity diagram giving colour spacing that is perceptually more uniform. This system is now rarely used except for calculation of the correlated colour temperature of light sources. The CIE 1976 u' v' diagram is now preferred
CIE 1976 Uniform Chromaticity Scale *Abbreviation:* CIE 1976 u' v' diagram	A simple modification of the now superseded CIE 1960 u v diagram such that v' = 1.5 v
CIE 1976 (L*u*v*) Space *Abbreviation:* CIELUV	A uniform colour space with an associated colour difference formula which is a linear transformation of either the 1931 standard observer or 1964 standard observer. It is used in the calculation of colour and colour differences in applications involving additive colour mixtures
CIE 1976 (L*a*b*) Space *Abbreviation:* CIELAB	An alternative uniform colour space with an associated colour difference formula which is a non-linear transformation of the 1931 standard observer. It is preferred for the calculation of small-colour differences of surface colours and is used in the textile industry, i.e. by dyeists and colourists



AUSTRALIAN STANDARD

GUIDE TO THE SPECIFICATION OF COLOURS

AS 2633—1983

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PREFACE

This standard was prepared by the Association's Committee on Lighting Standards, following a request by the Technical Management Group of SAA for guidance for committees and staff in the preparation of standards which involve the specification of colours. However, it is apparent that guidance of the kind provided in this standard will also be of assistance generally wherever problems involving the specification or assessment of colours are encountered.

Requirements for the specification of colours will vary depending on a number of factors, such as the degree of precision required and how the specification is to be applied. This standard describes the various systems that are in use for specifying colours and includes specific recommendations to assist in the selection of an appropriate method. Guidance is also given on the specification of tolerances.

Bibliographical details of the references given in the text are provided in an Annex. The Annex also includes several suggestions for further reading on the subject of colour.

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STANDARDS ASSOCIATION OF AUSTRALIA

Australian Standard

GUIDE TO THE SPECIFICATION OF COLOURS

SECTION 1. SCOPE AND GENERAL

1.1 SCOPE. This standard sets out the factors which should be taken into account in the specification of colours. It describes the various methods used to specify colours, and gives guidelines to assist in the selection of the most appropriate method of specification for a given application. Guidelines are also provided for the specification of tolerances.

NOTE: In this standard, the following abbreviations are used for designating the names of colours:

R — red
Y — yellow
G — green
B — blue
P — purple

Combinations of these designations are also used, e.g.

GY — green yellow

1.2 REFERENCED DOCUMENTS. A list with titles of the documents referred to in this standard is given in the Annex. The Annex also lists several documents which are suggested for further reading.

1.3 DEFINITIONS. For the purpose of this standard, the following definitions apply:

NOTE: The definitions are only intended to make clear the meaning given to certain terms used in this standard. For more technically precise definitions of some of the terms, reference should be made to AS 1852(45)*.

1.3.1 Brightness (luminosity)—the attribute of a visual sensation according to which an area appears to emit more or less light.

1.3.2 Chromaticity—property of a colour stimulus (involving the attributes of hue and saturation but not lightness) which may be defined by coordinates on a plane diagram in the CIE trichromatic system.

1.3.3 Chromaticity diagram—a plane diagram in which points specified by chromaticity coordinates represent the chromaticities of colour stimuli, each chromaticity being represented by a single point on the diagram.

NOTE: See Fig. 3.1 for an illustration of the CIE 1931 chromaticity diagram.

1.3.4 Colour—that aspect of the interaction of light both with the human visual system and with substances in the field of view of that system that gives rise to descriptive terms such as red, yellow, green, blue, purple, etc (chromatic colours) and white, black, grey, light, dark, etc (achromatic colours), and which can be described quantitatively in terms of three different light stimuli.

1.3.5 Colour domain—a defined region of chromaticities which may be represented by an area on a chromaticity diagram.

NOTE: Appendix A gives an example of the specification of colour domains, together with an illustration of the domains on a CIE 1931 chromaticity diagram.

1.3.6 Colour rendering—a general expression for the effect of a light source on the colour appearance of objects in comparison with their colour appearance under a reference light source.

NOTE: The colour rendering properties of a light source are usually specified in terms of the CIE General Colour Rendering Index (Ref. 2).

1.3.7 Colour solid—the part of colour space which contains colours that can be realized as surface colours.

1.3.8 Colour space—a three-dimensional geometric representation defining a range of colour, the dimensions of which are hue, saturation and lightness.

1.3.9 Correlated colour temperature (of a light source)—the temperature of the Planckian radiator whose perceived colour most closely resembles that of a given light source at the same brightness and under specified viewing conditions. The unit is the kelvin (K).

1.3.10 Hue—the attribute of colour perception by means of which an object is judged to be red, green, yellow, blue or intermediate between some adjacent pair of these. Black, white and neutral grey have no hue.

1.3.11 Illumination—the process of lighting an object.

1.3.12 Lightness (of a related colour)—the brightness of an area judged relative to the brightness of a similarly illuminated area that appears to be white or highly transmitting.

1.3.13 Luminous flux—the radiant flux (power) in a beam of radiation weighted by the agreed spectral responsivity of the human visual system. The unit is the lumen (lm).

NOTE: At the wavelength 555 nm, the weighting factor is 683 lumens per watt of radiation.

1.3.14 Munsell chroma—an index of the saturation of a colour expressed on a scale extending from /0 (no colour), by steps of approximately equal visual importance, to about /20 for the most saturated specimens producible.

1.3.15 Munsell colour notation—a system of letters or numbers, or both, by which the colour of any opaque object may be specified with respect to Munsell hue (*H*), Munsell value (*V*), and Munsell chroma (*C*), written in the form *H V*/*C*.

*AS 1852(45) is an Australian endorsement of IEC Publication 50 (45), International Electrotechnical Vocabulary: Group 45, Lighting. The definitions contained in Group 45 of the International Electrotechnical Vocabulary were prepared in collaboration with the International Commission on Illumination (CIE) and are identical with those given in CIE Publication No 17, International Lighting Vocabulary.