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Information technology — Office equipment — Viewing environment guideline for office equipment

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Foreword

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This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 28, *Office equipment*.

Introduction

Viewing conditions for imaging devices such as 2D and 3D printers/scanners, copiers, projectors, fax, displays and systems are specified in the various international standards and technical reports and can be categorized according to their objectives. Those objectives are colour assessment such as direct visual assessment and corresponding colorimetric measurements, defining colour space and colour comparison between display and print.

CIE 15 provides CIE recommendations for basic colorimetry which recommends CIE illuminant D65 used whenever possible and when D65 cannot be used, it is recommended that one of the daylight illuminants D50, D55 or D75 be used. ISO 13655 provides requirements for spectral measurements and colorimetric computations for graphic arts images and specifies CIE illuminant D50, which is used throughout the printing industry and provides a consistent and unambiguous framework for assessing colour.

ISO 3664 similarly provides requirements for the visual assessment of colour for graphic technology and photography and specifies CIE illuminant D50 for the same reasons as ISO 13655. IEC 61966-2-1 provides Default RGB colour space – sRGB which specified CIE illuminant D50 by referring ISO 3664. These and other international standards designed for graphic arts specify CIE illuminant D50 as the viewing illuminant ensuring consistent colour evaluation conditions.

The colour temperature of viewing illuminant in international standards specifying office lighting ranges from 5 000 K to 7 500 K. However, the colour temperature of the viewing illuminant where the product will be finally seen is largely a matter of personal taste. The general preference is to use cool colours for a business-like atmosphere (e.g. in offices, factories, shops) and warm colours for a social atmosphere (e.g. in hotels and homes). In office environment, popular viewing illuminants are F2 (4 230 K) and F6 (4 150 K) which are generally inexpensive and compromising business and social atmosphere.

End users have various requirements but in all cases it is beneficial to agree a reference viewing environment. A typical end user issue is where it is claimed that clouds and snows in original document have become too reddish in printed copy. Without having an agreed reference viewing illuminant the cause of such problems is hard to find and may be due, for example, to an incorrect assumption for the intended viewing environment.

For office equipment, reference viewing conditions are not specified or explained with relevant background information in any international standards. It is desirable to provide a guideline for selecting viewing conditions for office equipment colour assessment. This document provides an overview of an office viewing environment for the purpose of colour assessment, colorimetry and colour evaluation. It also provides a colour characterization guideline for use with office equipment. The objective of this document is to avoid misunderstanding of various viewing conditions recommended by many international standards and to help office equipment manufacturers selecting proper viewing conditions, so that they can provide products with suitable colour reproduction performance to satisfy user needs in various viewing environments.

Information technology — Office equipment — Viewing environment guideline for office equipment

1 Scope

This document provides an overview of office viewing environment and colour characterization guidelines for use with office equipment, in particular colour printing devices that have digital imaging capabilities, including multi-function devices.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
viewing environment
environment in which something is viewed

3.2
viewing conditions
description of the surrounding environmental conditions during the process of viewing

[SOURCE: ISO/TS 18173:2005, 2.28]

4 Viewing conditions

4.1 General

Information relating to viewing conditions are reviewed in this clause, including international standards, technical reports and web-based articles (as shown in Annex A). In general, colour assessment related standards specified viewing conditions. Colour assessment can be done basically in two ways. One is to use the human eyeball as a detector and the human brain to compute colour as a psychometric feeling – so called visual assessment. The other is to use an artificial sensor as a detector and a computer chip to compute colour coordinates – so called colorimetry. In multimedia systems and equipment, viewing conditions are specified for defining colour space. In graphic technology, viewing conditions are specified for proofing which involves colour comparison of the display and the printer.

4.2 Visual assessment

4.2.1 General

Viewing conditions for the visual assessment of colour are specified in several international standards. ISO 8995 applies to the lighting of indoor workplaces. ISO 3664 applies to viewing conditions for graphic

technology and photography. IEC 61966-2-1 applies to default colour space for multimedia systems and equipment. ISO 12646 applies to characteristics for displays for colour proofing.

4.2.2 Lighting of indoor workplaces

ISO 8995 specifies lighting requirements for indoor workplaces for people to perform visual tasks efficiently, in comfort and safety throughout the whole work period. Illuminance, glare limitation and colour quality are specified for various interiors (areas), tasks and activities. As described in ISO 8995, the “colour appearance” of a lamp refers to the apparent colour (lamp chromaticity) of the light it emits. It may be described by its correlated colour temperature. Lamps are usually divided into three groups according to their correlated colour temperature, such as warm, intermediate and cool. Correlated colour temperatures are below 3 300 K, 3 300 K to 5 300 K and above 5 300 K respectively. There are 260 different types of interior, task or activity and the distribution of number of types of interior, task or activity in terms of colour temperatures are:

— 13 belong to colour temperature of at least 4 000 K;

— one belongs to 5 000 K, which is for colour inspection in multi-coloured printing;

— two belong to 5 000 K or more, which are for operating cavity and colour inspection (laboratories);

— one belongs to more than 5 000 K, which is for art rooms in art schools;

— one belongs to 6 000 K or more, which is for white teeth matching;

— one belongs to 6 500 K or more, which is for colour inspection in the chemicals, plastics and rubber industries; and

— the other 241 belong to ‘not specified’. More than 90 % have no colour temperature given.

4.2.3 Graphic technology and photography

For graphic technology and photography, the viewing conditions are specified in ISO 3664. The viewing illuminant is specified as CIE illuminant D50. Differences in illumination and viewing conditions can cause corresponding differences in the colour appearance of substrates, reproductions and artwork. The objective of specifying the viewing illuminant in ISO 3664 is to reduce errors and misunderstandings caused by such deficiencies and inconsistencies. But, viewing conditions in ISO 3664 for print are not common in the general office environment. As a result, sometimes the colour of print in a general office does not match the colour of print based on ISO 3664 viewing conditions.

Reference ambient illuminance level when comparing an image on reflective print and a colour monitor is specified as CIE illuminant D50 in ISO 3664 such as "Recommended ambient illumination for colour monitors: ≤32 lx." and "Required ambient illumination for colour monitors: ≤64 lx". But, it is difficult to set ambient illumination in an office to be the same as the one specified in ISO 3664 because that is too dark to see print in general working usage. As a result, the colour of prints do not match between ISO 3664 and the general office.

4.2.4 Multimedia systems and equipment

IEC 61966-2-1 adopted the viewing conditions specified in ISO 3664 as follows.

Specifications for the reference viewing environments are derived from ISO 3664 and shall be as follows:

a) reference background for the background as part of the display screen, the background is 20 % of the reference display luminance level (16 cd/m2); the chromaticity should average to x = 0,312 7, y = 0,329 0 (D65);

b) reference surround 20 % reflectance of the reference ambient illuminance level (12,8 lx); the chromaticity should average to x = 0,345 7, y = 358 5 (D50) illuminance level;

c) reference proximal field 20 % of the reference display luminance level (16 cd/m^2); the chromaticity should average to x = 0,312 7, y = 0,329 0 (D65);

d) reference ambient illuminance level 64 lx;

e) reference ambient white point x = 0,345 7, y = 0,358 5 (D50);

f) reference veiling glare 1,0 %.

Furthermore, as described in IEC 61966-2-1:1999, Annex D, the typical ambient illuminance level in a typical office is 350 lx.

4.2.5 Displays for colour proofing

Comparison of monitor and hard copy images are specified in ISO 12646. At the centre of the white image defined in ISO 12646:2015, 5.3, the chromaticity of the display should be set to that of D50; namely u′ = 0,209 2, v′ = 0,488 1 (as specified in CIE Publication 15). The chromaticity obtained for the white point chosen by the software application vendor is within a circle of radius 0,005 from this point. The luminance of the monitor should be as high as necessary to visually match an unprinted sheet of white paper located close to the monitor having an illuminance of 500 lx, as specified in ISO 3664 for viewing condition P2. If that is not possible, the luminance should be at least 80 cd/m^2 but preferably 160 cd/m^2. The conditions within the viewing booth conform to viewing condition P2 of ISO 3664. An example of viewing conditions for image comparison between hardcopy and display is introduced in Annex B.

4.3 Colorimetry

4.3.1 General

Viewing conditions for colorimetry (the physical measurement of colour) are specified in several international standards and technical reports. CIE 15 is the recommendation of the CIE concerning basic colorimetry. The IEC 61966 series relates to colour characterization of multimedia systems and equipment. ISO 13655 is the colorimetry standard for graphic technology and photography.

4.3.2 Basic colorimetry

In CIE 15 it is recommended that the following illuminants, defined by relative spectral power distributions given ISO/CIE 10526:1999, Table 1,[1)] be used for general colorimetry.

— CIE standard illuminant A, CIE standard illuminant D65, illuminant B, illuminant C.

— It is recommended that, in the interest of standardization, D65 be used whenever possible.

— When D65 cannot be used, it is recommended that one of the daylight illuminants D50, D55, or D75 defined in ISO/CIE 10526:1999, Table 1 be used.

1) Withdrawn in 2007. Also published as CIE S005/E-1998. *CIE standard illuminants for colorimetry*, 1998.

4.3.3 Graphic technology and photography

For graphic arts images the viewing illuminant is specified in ISO 13655, for example, the spectral power distribution of the light flux incident on the specimen surface for the measurement should match CIE illuminant D50. To obtain consistency of instrumental measurement data and visual assessment data using viewing booths, it is desirable to adopt the same viewing illuminant, such as D50, for both instrumental measurement and visual assessment.

4.3.4 Multimedia systems and equipment

For colour printers the viewing illuminant is specified in IEC 61966-7-1, for example, default illuminants and colorimetric observers to derive Tristimulus values and CIELAB colour space is D50. IEC 61966-7-1 also specified D65, F11 and illuminant A as optional viewing illuminants.

4.4 Office equipment

4.4.1 General

As described in ISO 8995-1:2002, 4.6.1, the choice of colour appearance is a matter of psychology, aesthetics and of what is considered to be natural. The choice depends on illuminance, the colours of the room and furniture, the surrounding climate and the application. In warm climates a cooler light colour appearance is generally preferred, and in cold climates a warmer light colour appearance is preferred.

Current office environments contain many different use cases, from high-end graphic arts to low-end consumer products. Even though there is no standard which specifies how to choose suitable viewing conditions, end users have various requirements so there are several different viewing condition assumptions that are desirable in order to resolve each end user issue. If an end user issue, for example, claimed the clouds and snows in an original document became too reddish in the output copy, it can be assumed that the viewing illuminant selection of designing colour-matching functions of the corresponding colour copier was at too high a colour temperature, such as D65.

4.4.2 Office lighting for imaging

The colour temperature of viewing illuminant at which the product will be finally seen is largely a matter of personal taste. The general preference is to use cool colours for a business-like atmosphere (e.g. in offices, factories, shops) and warm colours for a social atmosphere (e.g. in hotels and homes). However there is considerable differences among countries in terms of the most popular light colour of fluorescent lamp which is commonly used in offices. The favourable colour temperature in both continental Europe and North America is 4 000 K Neutral White which strikes a balance between creating a professional atmosphere while providing a feeling of warmth for a friendly working environment. In the office environment, popular viewing illuminants are F2 (4 230 K) and F6 (4 150 K). According to ISO 8995-1, as described in 4.2.2, there are 260 different types of interior, task or activity and no colour temperature is specified for 90 % of those workplaces. F2 (4 230 K) and F6 (4 150 K) are generally inexpensive among other colour temperatures, and that is one of the biggest reasons these are popular light sources.

CIE Division 8 conducted worldwide data acquisition of spectral distribution of office lighting for imaging and distribution of the colour temperatures of office lighting. The data showed that the colour temperature range is 4 000 K – 5 000 K which is different from the colour temperatures specified in the above international standards, such as 5 000 K – 7 500 K.

CIE Division 8 data includes reference ambient illuminance level. The data showed that the average ambient illuminance level is approximately 350 lx, which is about 500 lx divided by square root of two. This value is 5,5 times the maximum limit of display (see 4.2.4).

4.4.3 Colour copying machines

ISO/IEC 15775 specifies D65 for colour copying machines for colour reproduction evaluation.

5 Guideline for office colour assessment

5.1 General

Graphic technology and photography adopted D50 for consistent data comparison. Office equipment manufacturers accumulate their base data using the same viewing condition as graphic technology and photography for designing their products for consistent data comparison. On the other hand, end users are in various viewing environments, so that it is difficult to pick one light source to know every end user's degree of satisfaction. A better approach to gain end user satisfaction is to use more light sources corresponding to each end user's viewing environment.

5.2 Visual assessment

Assessment operation involving multiple light sources requires a high workload and cost in visual assessment. An alternative approach is to pick an average light source for the office environment. If there is a significant mismatch with D50, use a light source to reflect regional and ethnic preferences appropriately. Annex C shows an actual office viewing environment.

5.3 Colorimetry

Once the spectral characteristics of object colour are available, it is easy to estimate colours of the same object with multiple light sources so the viewing illuminant can be selected to match each objective. Measurement data reporting requirements are available in ISO 13655, which includes required information, recommended information and electronic data reporting.

5.4 Recommendation

Annex D shows the availability of viewing conditions for evaluation. Currently there is no conventional visual assessment standard in an actual office user environment. In addition, LED light sources with variable colour temperature, are commercialized and spreading around the world in recent years. So, it is desirable to develop a viewing evaluation method for office equipment.