International Standard

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Permanence and durability of commercial prints —

Part 22: Backlit display in indoor or shaded outdoor conditions — Light stability

Permanence et durabilité des impressions commerciales —

Partie 22: Écran rétroéclairé en intérieur ou en extérieur ombragé — Stabilité de la lumière

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 42, *Photography*.

The first edition of ISO 21139-22 cancels and replaces the first edition of ISO/TS 21139-22:2023, which has been technically revised.

The main changes are as follows:

— the Technical Specification was developed into an International Standard.

A list of all parts in the ISO 21139 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Backlit display of prints is a market segment in the context of commerce (advertisement, brand shops) and information (maps, directories). In this use profile the backlit prints are irradiated from their frontside and from their backside, with irradiations on both sides typically differing by their intensity and spectral distribution.

Backlit display applies with prints on transparent or translucent foils and/or prints on a textile. This document focusses on LED-based backlit units and provides information about fluorescent-based backlit units for reference. These backlit displays may be installed indoor or in shaded outdoor display conditions, for examples backlit display units in shelters and patios. Backlit displays which are subject to solar radiative heating or precipitation, introducing extensive temperature cycling, are excluded.

Prints on backlit display may fade or otherwise change in appearance due to various environmental stresses, including irradiation, heat, humidity, atmospheric pollutants, or biological attack, and the combination of these factors. One of the most critical degradations is light fading caused by intense irradiation from the backlit unit as well as by the general irradiation from the viewing environment, which may represent various levels of intensity and spectral distribution, depending on the installation site in a building, near to a window or in a shaded outdoor display condition.

The irradiation of the backlit print is therefore typically different from its frontside (oriented towards the viewing environment) compared to its backside (oriented towards the backlit unit).

In this document, the intensity of the irradiation from either frontside or backside is characterized in terms of illuminance, E_v, and the accumulated dose by luminous exposure, H_v. Spectral distributions, which cause varying rates of light fading due to their different UV content, are accounted for by a dimensionless factor called "relative severity". This factor compares the fading rates of a specific type of irradiation condition to those under the standardized exposure condition called "general indoor display" (according to ISO 18937-2), both evaluated at the same illuminance, E_v, as explained in Annex A.

The lighting design of the backlit display unit may cause inhomogeneity of the backside exposure of the print, which may in turn introduce inhomogeneous patterns of colour fading or discoloration leading to enhanced visibility of degradation (an example is illustrated in Annex B). The test method described in this document does not include the assessment of the impact from inhomogeneity of the backside exposure.

This document provides information about the test conditions for colour fading and discoloration applicable for the different types of display materials, including transparent films or translucent films, papers, and fabrics. Furthermore, this document gives guidance for estimation of an equivalent luminous exposure for the intended time of display, acknowledging the limitations of such generic extrapolations. The display use profile applies for digital and analogue prints.

The test method described in this document does not address the adverse effects of exposure to atmospheric pollutants, including ozone, and is also limited to the evaluation of colour changes and therefore does not require specific methods for the evaluation of physical properties, including changes of tensile strength, cockling etc. In the case that backlit materials are constructed from laminates, the aforementioned factors are of less importance.

The general concepts for the exposure characterization of prints on a backlit display provided in this document may also be considered in museum context with details defined by ISO/TS 18950.

Permanence and durability of commercial prints —

Part 22: Backlit display in indoor or shaded outdoor conditions — Light stability

1 Scope

This document specifies the test method for light stability measurements of prints on transparent or translucent foils, transparent or translucent film, and paper or printed on a textile, which are displayed on backlit units installed in indoor or in shaded outdoor conditions, which are protected against direct precipitation and radiative heating. Installations of backlit display units in outdoor areas without shading, which are exposed to direct weathering and/or radiative heating, are excluded.

This document is applicable to the various product classes of "commercial prints" that are suitable for backlit display. These commercial prints often contain combinations of text, pictorial images and/or artwork.

This document provides guidelines for colour measurements, data analysis, and also provides guidance for translation of test results into suitable image permanence performance claims considering the variability of backlit designs and environmental conditions.

This document is applicable to both analogue and digitally printed matter. Methods and principles apply to both colour and monochrome prints.

NOTE The test method in this document does not address the specific requirements for testing museum backlit display, however, some of the elements in this test method (such as exposure in both directions) can also be considered in museum context with details defined by ISO/TS 18950.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/CIE 11664-1, *Colorimetry — Part 1: CIE standard colorimetric observers*

ISO/CIE 11664-2, *Colorimetry — Part 2: CIE standard illuminants*

ISO/CIE 11664-4, *Colorimetry — Part 4: CIE 1976 L*a*b* colour space*

ISO 18937-1, *Imaging materials — Methods for measuring indoor light stability of photographic prints — Part 1: General guidance and requirements*

ISO 18937-2, *Imaging materials — Methods for measuring indoor light stability of photographic prints — Part 2: Xenon-arc lamp exposure*

ISO/PAS 18940-1, *Imaging materials — Image permanence specification of reflection photographic prints for indoor applications — Part 1: Test methods*

3 Terms and definitions

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

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

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

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

3.1 Symbols and abbreviated terms

CCT	correlated colour temperature - see International Electrotechnical Vocabulary (IEV) ref: 845-23-068
CIE	Commission internationale de l'éclairage (International Commission on Illumination)
RSD	relative spectral distribution,
GI	RSD of the test condition "General Indoor display" – see ISO 18937-2
ΔE^*_{ab}	CIELAB colour difference defined in ISO/CIE 11664-4
$\Delta E^*_{ab,ave}$	average of the CIELAB colour differences of the patches of the test target (vs. initial) as defined in ISO/PAS 18940-1
$\Delta E^*_{ab,wst}$	average of the CIELAB colour differences of the two patches of the test target (vs. initial) with the highest and the second highest CIELAB colour difference as defined in ISO/PAS 18940-1
ΔE_{00}	CIEDE2000 colour difference as defined in ISO/CIE 11664-6[3]
E_v	illuminance
τ	duty cycle
$\tilde{H}_{v,\Delta E^*_{ab}}$	severity-weighted luminous exposure at which a CIELAB colour change ΔE^*_{ab} is observed

3.2 Measures of exposure severity

3.2.1
relative spectral distribution
$S(\lambda)$

quotient of the spectral distribution, $X_\lambda(\lambda)$, of a radiant, luminous or photon quantity, $X(\lambda)$, and a fixed reference value, R, which can be an average value, a maximum value or an arbitrarily chosen value of this distribution

$$S(\lambda) = \frac{X_\lambda(\lambda)}{R}$$

Note 1 to entry: The relative spectral distribution has unit one.

[SOURCE: IEV ref: 845-23-068, modified – NOTE 2 to entry has been removed.]

3.2.2
relative severity

$\rho_{S/S_{\text{ref}}}$

ratio of the expected density loss due to light fading for exposure under a given *relative spectral distribution, $S(\lambda)$* (3.2.1) in comparison to a reference $S_{\text{ref}}(\lambda)$ with both exposures at the same level of illuminance, E_{v}, as evaluated based by an average action spectrum model (see Annex A)

Note 1 to entry: For typical relative spectral distributions $S(\lambda)$ the degree of light fading obtained for the same amount of luminous energy has been expressed in relative units to each other based on experimental data and an action spectrum model obtained for typical CMY colorants used in digital printing, see Annex A.

Note 2 to entry: Standardized relative spectral distributions $S(\lambda)$ include daylight filtered Xenon-arc (see ISO 18930), window-glass filtered Xenon-arc for simulated in-window display or with additional UV blocking for general indoor display (see ISO 18937-2), fluorescent light (see ISO 18909) and LED light (see ISO 18937-3).

EXAMPLE In this document, $\rho_{S/\text{GI}}$ denotes the relative severity of a given relative spectral distribution $S(\lambda)$ compared to that of the reference exposure test condition “General indoor display”.

3.2.3
severity-weighted illuminance

$\tilde{E}_{\text{v},S/S_{\text{ref}}}$

effective illuminance caused by a light source with a *relative spectral distribution, $S(\lambda)$*, (3.2.1) that is obtained by multiplying its illuminance, E_{v}, with the duty cycle τ (in %) in the application and its *relative severity* (3.2.2) in comparison to a continuous exposure with a reference relative spectral distribution $S_{\text{ref}}(\lambda)$

Note 1 to entry: $\tilde{E}_{\text{v},S/S_{\text{ref}}} = E_{\text{v}} \cdot \tau \cdot \rho_{S/S_{\text{ref}}}$.

Note 2 to entry: In this test method, the relative spectral distribution of the general indoor filtered Xenon-arc test method as defined in ISO 18937-2 is used as the reference, so $S_{\text{ref}}(\lambda)$ = GI. The required spectral irradiation can be achieved by using a window-glass filtered Xe-arc lamp with additional optical filters such as L-37 (Hoya Co.) and SC-37 (Fujifilm Co.).

Note 3 to entry: The severity-weighted luminous exposures of the frontside and the backside of a print displayed on a backlit unit typically differ because of different relative spectral distributions, duty cycles and/or intensity.

3.2.4
severity-weighted luminous exposure

$\tilde{H}_{\text{v},S/S_{\text{ref}}}$

luminous exposure resulting from luminous energy of a *severity-weighted illuminance*, $\tilde{E}_{\text{v},S/S_{\text{ref}}}$, (3.2.3) that is accumulated over an exposure time, t_{exp}

Note 1 to entry: In this test document, the relative spectral distribution of the general indoor filtered Xenon-arc test method as defined in ISO 18937-2 is used as the reference, so $S_{\text{ref}}(\lambda)$ = GI (“General indoor display”).

Note 2 to entry: The severity-weighted luminous exposures on the frontside and the backside of a backlit displayed print, respectively, are typically different and both contribute to colour fading.

3.2.5
UV cut-on

$\lambda_{\text{cut-on}}$

wavelength at which the cumulative intensity of a *relative spectral distribution, $S(\lambda)$*, (3.2.1) has reached 0,05 % of its total integrated intensity over the spectral range of 295 nm to 800 nm

Note 1 to entry: $\int_{295\,\text{nm}}^{\lambda_{\text{cut-on}}} S(\lambda)\,\text{d}\lambda \Big/ \int_{295\,\text{nm}}^{800\,\text{nm}} S(\lambda)\,\text{d}\lambda = 0,05\,\%$.