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Secretariat: ANSI

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# Permanence and durability of commercial prints — Part 22: Backlit display in indoor or shaded outdoor conditions — Light stability

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ISO 20344, Personal protective equipment — Test methods for footwear

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## Contents

 

## 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 documents 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).~~www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see ~~www.iso.org/patents).~~www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 the following URL ~~www.iso.org/iso/foreword.html.~~www.iso.org/iso/foreword.html.

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

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.~~www.iso.org/members.html.



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## Introduction

Backlit display of prints is a market segment in context of commerce (advertisement, brand shops) and information (maps, directories). This use profile has specific spectral irradiance and environmental conditions which are different from e.g. general indoor or in-window display (ISO/TS 21139-21).

Backlit display applies with prints on transparent or translucent foils and/or prints on a textile. The document focusses on LED-based backlit units and on the other hand provides information on fluorescent-based backlit units for reference. These backlit displays may be installed indoor or in shaded outdoor 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 light, 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 illumination from the viewing environment, which may represent various levels of intensity and degrees of spectral irradiance, depending on the installation site in a building, near to a window or in a shaded outdoor condition. The factors determining the exposure doses form either frontside or backside are introduced, and the severity of the actual spectral irradiance is expressed as a ratio to the standardized exposure condition “general indoor” as defined by ISO 18937-2.

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 or translucent films, fabrics as well as paper-based reflection prints. Furthermore, the document gives guidance for estimation of an equivalent exposure dose for the intended time of display, acknowledging the limitations of such generic extrapolations. The display use profile applies for digital and analogue prints.

This test method 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.

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# Permanence and durability of commercial prints — Part 22: Backlit display in indoor or shaded outdoor conditions — Light stability

## 1 Scope

This document describes the test methods for light stability measurements of prints on transparent or translucent foils, sheets 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.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

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

~~<std>~~ISO/TS 21139-1, *Permanence and durability of commercial prints — Part 1: Definition of use profiles and guiding principles for specifications*~~</std>~~

~~<std>ISO/TS 21139-21, *Permanence and durability of commercial prints — Part 21: In-window display — Light and ozone stability*</std>~~

ISO/TS 21139-21, *Permanence and durability of commercial prints — Part 21: In-window display — Light and ozone stability*

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ISO/PAS 18940-1, Imaging materials — Image permanence specification of reflection photographic prints — Part 1: Test method

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## 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:

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

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

~~**3.1 abbreviations**~~

### 3.1 Measures of exposure severity

**3.1.1**

relative~~CCT~~ ~~correlated colour temperature (IEV ref: 845-23-068)~~

~~CIE~~ ~~Commission internationale de l'éclairage (International Commission on Illumination)~~

~~$\Delta E_{ab}$~~ ~~colour difference defined in ISO/CIE 11664-4[2]~~

~~$\Delta E_{ab,ave}$~~ ~~average of the colour differences of the patches of the test target (vs. initial)~~

~~$\Delta E_{ab,max}$~~ ~~maximum of the colour differences of the patches of the test target (vs. initial)~~

~~$\Delta E_{00}$~~ ~~colour difference ΔE2000 as defined in ISO/CIE 11664-6[3]~~

~~klx·h~~ ~~kilolux times hour~~

~~Mlx·h~~ ~~megalux times hour~~

~~*RSI*~~ ~~relative spectral irradiance in W / (m² nm)~~

~~GI~~ ~~*RSI* defined by the test condition "General Indoor" see ISO 18937-2~~

~~$E_v$ [klx]~~ ~~illuminance (visually weighted)~~

~~$\tilde{E}_v^{GI}$ [klx]~~ ~~illuminance at the test condition of "General Indoor"~~

~~τ [%]~~ ~~duty cycle~~

~~$\tilde{H}_{\Delta Eab}$~~ ~~severity weighted exposure dose at which a certain colour change $\Delta E_{ab}$ is observed~~

~~**3.17 measures of exposure**~~ **severity**

~~**3.2.1**~~

~~**relative severity**~~

~~$\rho_{RSI_1/RSI_2}$~~

$\rho_{RSI1/RSI2}$

ratio of density loss due to light fading for exposure under a given RSI1 in comparison to another given RSI2 with both exposures at the same level of illuminance ~~$E_v$ [klx]~~ $E_v$ [klx], based on the evaluation of average light fading for a set of colorants used in digital prints

Note 1 to entry: ~~for~~For standardized RSI the relative degree of light fading obtained for the same exposure dose expressed in klx·h 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. The combined information of exposure intensity [klx] and ~~$\rho_{RSI_1/RSI_2}$~~ $\rho_{RSI1/RSI2}$ is therefore equivalent to the description of a spectral exposure, see Annex A.

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Note 2 to entry: ~~standardized~~Standardized RSI 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~~ In this method, ~~$\rho_{RSI/\,GI}$~~ $\rho_{\mathrm{RSI/\,GI}}$ denotes the relative severity of a RSI under question compared to the condition of "General Indoor" exposure.

**3.1.2.~~2~~**
**severity weighted exposure**

~~$\tilde{E}_{RSI_1/RSI_2}$~~

$\tilde{E}_{\mathrm{RSI1/RSI2}}$

measure of the exposure intensity of a given RSI1 ~~(3.2.2).~~, where the illuminance ~~$E_v$ [klx]~~ $E_{\mathrm{v}}$ [klx] is weighted with the duty cycle $\tau$ [%] in application and with the *relative severity* (3.~~2~~1.1) in comparison to a reference RSI2~~.~~

Note 1 to entry: In this test method, the RSI of the general indoor filtered Xenon-arc test method as defined in ISO 18937-2 is used as the reference RSI, so RSI2 = GI. This spectral irradiance can be achieved using optical filters such as L-37 (Hoya Co.) and SC-37 (Fujifilm Co~~This spectral irradiance can be achieved using optical filters such as L-37 (Hoya Co.) and SC-37 (Fujifilm Co.).~~).

Note 2 to entry: The severity weighted exposures of the frontside and the backside of a print display on a backlit unit are typically different because of different RSIs, duty cycles and/or intensity.

**3.~~2~~1.3**
**severity weighted exposure dose**

~~$\tilde{H}_{RSI_1/RSI_2}$~~

$\tilde{H}_{\mathrm{RSI1/\,RSI2}}$

measure of the severity weighted exposure that is accumulated during a nominal display duration time, $t$

Note 1 to entry: In this test method, the RSI of the general indoor filtered Xenon-arc test method as defined in ISO 18937-2 is used as the reference RSI, so RSI2 = GI ("General Indoor").

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

## ~~3.1~~83.2 ~~exposure~~Exposure conditions

**3.~~3~~2.1**
**UV cut-on [wavelength]**

$\lambda_{0,05\,\%}$

wavelength at which the cumulative intensity of a RSI $I(\lambda)$ has reached 0,05 % of its total integrated intensity over the spectral range of 295 nm to 800 nm~~.~~

Note 1 to entry: ~~$\int_{295\,nm}^{\lambda\,0,05\,\%} I(\lambda)\,d\lambda / \int_{295\,nm}^{800\,nm} I(\lambda)\,d\lambda = 0,05\,\%$~~ $\int_{295\,\mathrm{nm}}^{\lambda\,0,05\,\%} I(\lambda)\,\mathrm{d}\lambda / \int_{295\,\mathrm{nm}}^{800\,\mathrm{nm}} I(\lambda)\,\mathrm{d}\lambda = 0,05\,\%$

**~~3.~~3.2.~~2~~**






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**shaded outdoor conditions**
exposure to indirect terrestrial daylight in a shadow zone, that is characterized by the absence of radiative heating of the prints on backlit display.

Note 1 to entry: theThe UV cut-on ($\lambda_{0,05\,\%}$) is in the range of 295 nm to 310 nm.

EXAMPLES: display Display in outside shelters and patios.

**3.32.3**
**glass-filtered shaded outdoor display**
exposure to *shaded outdoor conditions* (3.2.2) with optical filtering of the irradiance by the front screen material of the backlit display unit.

Note 1 to entry: Backlit display units in shaded outdoor conditions practically always require a front screen in front of the print for reasons of electrical safety. Such a front screen is most often realized by safety glass or a similar suitable material. The UV cut-on of PVB laminated safety glass varies between 300 nm to 400 nm depending on its construction and its material formulation. For the purpose of this standard, 6 mm window glass is defined as reference for the filter transmission, acknowledging that the UV transmission of different types of front screens varies.

EXAMPLES: display Display in backlit units in shaded outdoor conditions with a safety glass front screen.

**3.32.4**
**in-window display**
exposure to indirect terrestrial daylight through standard architectural window glass (6 mm)

Note 1 to entry: theThe UV cut-on ($\lambda_{0,05\,\%}$) is around 320 nm.

EXAMPLES: display Display in store windows or in other glass-enclosed architectural constructions (hallways, lobbies, verandas), that face toward the outdoors.

**3.32.5**
**general indoor display**
exposure to indirect lighting, from due to filtering (through window glass) and shading is often the principal illumination

Note 1 to entry: theThe UV cut-on ($\lambda_{0,05\,\%}$) is around 350 nm.

EXAMPLES: display Display in store windows or in other glass-enclosed architectural constructions (hallways, lobbies, verandas), that face toward the outdoors.

## 3.3 Abbreviations

| | |
|---|---|
| CCT | correlated colour temperature (IEV ref: 845-23-068) |
| CIE | Commission internationale de l'éclairage (International Commission on Illumination) |
| $\Delta E_{ab}$ | colour difference defined in ISO/CIE 11664-4[2] |
| $\Delta E_{ab,\,ave}$ | average of the colour differences of the patches of the test target (vs. initial) |
| $\Delta E_{ab,\,max}$ | maximum of the colour differences of the patches of the test target (vs. initial) |
| $\Delta E_{00}$ | colour difference ΔE2000 as defined in ISO/CIE 11664-6[3] |
| klx·h | kilolux times hour |



 

| | |
|---|---|
| Mlx·h | megalux times hour |
| RSI | relative spectral irradiance in W/(m² nm) |
| GI | RSI defined by the test condition "General Indoor" – see ISO 18937-2 |
| $E_v$ [klx] | illuminance (visually weighted) |
| $\tilde{E}_v^{GI}$ [klx] | illuminance at the test condition of "General Indoor" |
| $\tau$ [%] | duty cycle |
| $\tilde{H}_{\Delta Eab}$ | severity weighted exposure dose at which a certain colour change $\Delta E_{ab}$ is observed |

## 4 Use profile

### 4.1 General

This document describes a test method for prints on transparent or translucent foils and/or on textiles that are displayed on backlit units indoors or in shaded outdoor conditions, where the primary stress factors are exposure to light from both backside and frontside.

~~Note~~ NOTE 1~~:~~ Heat, humidity and atmospheric pollutants can also be stress factors, however this document focuses on light stability. Heat can have effects on prints that are displayed for long time periods on backlit units with elevated temperature, e.g. due to radiative heating by sunlight through window glass or due to dissipative heating from electrical appliances in poor-ventilated constructions of the backlit unit itself.

The use profile of commercial prints is described in general in ISO/TS 21139-1. ~~This part~~It specifically describes test methods for backlit display indoor and in shaded outdoor conditions, defined as display use profiles ~~A.3~~A3 and B1- b) of ~~Table 3 in~~ ISO/TS 21139-1:2019, Table 3, respectively.

~~Note~~ NOTE 2~~:~~ The overall appearance of the displayed prints can also be affected by factors given by the backlit unit itself, including a non-homogenous distribution of the intensity and/or the correlated colour temperature (CCT) of the backlit lighting and/or changes of any other element of the backlit unit, e.g. yellowing of the front screen.

### 4.2 Parameters of backlit display

A backlit display unit is designed to provide a backside illumination of the print, such that the brightness of the displayed print is comparable to or larger than the light level of the surrounding viewing environment. Furthermore, the CCT of the lamps in the backlit unit is often selected to match the viewing environment, which is typically between 5 000 K to 6 500 K for naturally illuminated areas and 3 000 K or 4 000 K for some indoor installations.

The spectral irradiance, intensity, and homogeneity of the backside exposure of the print depends on the construction of the backlit unit. These parameters together with the duty cycle of the backside illumination determine the severity of the exposure of the print from its backside. Table 1 provides an overview of typical parameters associated with LED or fluorescent lamp illuminated light box designs.

The level of temperature increase of the print on backlit display is driven by the dissipative heating from the backlit lighting system in operation and the degree of air ventilation of the light box in a certain environment. The amount of temperature increase is larger in the case of poor air ventilation. Factors that reduce air ventilation include an airtight design of the housing, its eventual installation onto or especially into a wall, the use of a front screen and/or the display of a print on a foil (as opposed to a

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