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Photography — Processed photographic colour films and paper prints — Methods for measuring image stability

Photographie — Films et papiers photographiques couleur traités — Méthodes de mesure de la stabilité de l'image

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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 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).

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).

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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*.

This second edition cancels and replaces the first edition (ISO 18909:2006), of which it constitutes a minor revision. The changes are as follows:

— a corrigendum published in 2006 has been incorporated, and

— updates have been made to align and compliment test methods for digital print materials.

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.

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Introduction

This document is divided into two parts. The first covers the methods and procedures for predicting the long-term, dark storage stability of colour photographic images; the second covers the methods and procedures for measuring the colour stability of such images when exposed to light of specified intensities and spectral distribution, at specified temperatures and relative humidities.

Today, the majority of continuous-tone photographs are made with colour photographic materials. The length of time that such photographs are to be kept can vary from a few days to many hundreds of years and the importance of image stability can be correspondingly small or great. Often the ultimate use of a particular photograph may not be known at the outset. Knowledge of the useful life of colour photographs is important to many users, especially since stability requirements often vary depending upon the application. For museums, archives, and others responsible for the care of colour photographic materials, an understanding of the behaviour of these materials under various storage and display conditions is essential if they are to be preserved in good condition for long periods of time.

Organic cyan, magenta and yellow dyes that are dispersed in transparent binder layers coated on to transparent or white opaque supports form the images of most modern colour photographs. Colour photographic dye images typically fade during storage and display; they will usually also change in colour balance because the three image dyes seldom fade at the same rate. In addition, a yellowish (or occasionally other colour) stain may form and physical degradation may occur, such as embrittlement and cracking of the support and image layers. The rate of fading and staining can vary appreciably and is governed principally by the intrinsic stability of the colour photographic material and by the conditions under which the photograph is stored and displayed. The quality of chemical processing is another important factor. Post-processing treatments, such as application of lacquers, plastic laminates and retouching colours, may also affect the stability of colour materials.

The two main factors that influence storage behaviour, or dark stability, are the temperature and relative humidity of the air that has access to the photograph. High temperature, particularly in combination with high relative humidity, will accelerate the chemical reactions that can lead to degradation of one or more of the image dyes. Low-temperature, low-humidity storage, on the other hand, can greatly prolong the life of photographic colour images. Other potential causes of image degradation are atmospheric pollutants (such as oxidizing and reducing gases), micro-organisms and insects.

Primarily the intensity of the illumination, the duration of exposure to light, the spectral distribution of the illumination, and the ambient environmental conditions influence the stability of colour photographs when displayed indoors or outdoors. (However, the normally slower dark fading and staining reactions also proceed during display periods and will contribute to the total change in image quality). Ultraviolet (UV) radiation is particularly harmful to some types of colour photographs and can cause rapid fading as well as degradation of plastic layers such as the pigmented polyethylene layer of resin-coated (RC) paper supports.

In practice, colour photographs are stored and displayed under varying combinations of temperature, relative humidity and illumination, and for different lengths of time. For this reason, it is not possible to precisely predict the useful life of a given type of photographic material unless the specific conditions of storage and display are known in advance. Furthermore, the amount of change that is acceptable differs greatly from viewer to viewer and is influenced by the type of scene and the tonal and colour qualities of the image.

After extensive examination of amateur and professional colour photographs that have suffered varying degrees of fading or staining, no consensus has been achieved on how much change is acceptable for various image quality criteria. For this reason, this document does not specify acceptable end-points for fading and changes in colour balance. Generally, however, the acceptable limits are twice as wide for changes in overall image density as for changes in colour balance. For this reason, different criteria have been used as examples in this document for predicting changes in image density and colour balance.

Pictorial tests can be helpful in assessing the visual changes that occur in light and dark stability tests, but are not included in this document because no single scene is representative of the wide variety of scenes actually encountered in photography.

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In dark storage at normal room temperatures, most modern colour films and papers have images that fade and stain too slowly to allow evaluation of the dark storage stability simply by measuring changes in the specimens over time. In such cases, too many years would be required to obtain meaningful stability data. It is possible, however, to assess in a relatively short time the probable long-term fading and staining behaviour at moderate or low temperatures by means of accelerated ageing tests carried out at high temperatures. The influence of relative humidity also can be evaluated by conducting the high-temperature tests at two or more humidity levels.

Similarly, information about the light stability of colour photographs can be obtained from accelerated light-stability tests. These require special test units equipped with high-intensity light sources in which test strips can be exposed for days, weeks, months or even years, to produce the desired amount of image fading (or staining). The temperature of the specimens and their moisture content shall be controlled throughout the test period, and the types of light sources shall be chosen to yield data that can be correlated satisfactorily with those obtained under conditions of normal use.

Accelerated light stability tests for predicting the behaviour of photographic colour images under normal display conditions may be complicated by reciprocity failure. When applied to light-induced fading and staining of colour images, reciprocity failure refers to the failure of many dyes to fade, or to form stain, equally when dyes are irradiated with high-intensity versus low-intensity light, even though the total light exposure (intensity × time) is kept constant through appropriate adjustments in exposure duration (see Reference [1]). The extent of dye fading and stain formation can be greater or smaller under accelerated conditions, depending on the photochemical reactions involved in the dye degradation, the kind of dye dispersion, the nature of the binder material, and other variables. For example, the supply of oxygen that can diffuse from the surrounding atmosphere into a photograph's image-containing emulsion layers may be restricted in an accelerated test (dry gelatin is an excellent oxygen barrier). This may change the rate of dye-fading relative to that which would occur under normal display conditions. The temperature and moisture content of the test specimen also influence the magnitude of reciprocity failure. Furthermore, light fading is influenced by the pattern of irradiation (continuous versus intermittent) as well as by light/dark cycling rates.

For all these reasons, long-term changes in image density, colour balance and stain level can be reasonably estimated only for conditions similar to those employed in the accelerated tests, or when good correlation has been confirmed between accelerated tests and actual conditions of use.

In order to establish the validity of the test methods for evaluating the dark and light stability of different types of photographic colour films and papers, the following product types were selected for the tests:

a) colour negative film with incorporated oil-soluble couplers;

b) colour negative motion picture pre-print and negative films with incorporated oil-soluble couplers;

c) colour reversal film with incorporated oil-soluble couplers;

d) colour reversal film with incorporated Fischer-type couplers;

e) colour reversal film with couplers in the developers;

f) silver dye-bleach film and prints;

g) colour prints with incorporated oil-soluble couplers;

h) colour motion picture print films with incorporated oil-soluble couplers;

i) colour dye imbibition (dye transfer) prints;

j) integral colour instant print film with dye developers;

k) peel-apart colour instant print film with dye developers;

l) integral colour instant print film with dye releasers.

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The results of extensive tests with these materials showed that the methods and procedures of this document can be used to obtain meaningful information about the long-term dark stability and the light stability of colour photographs made with a specific product. They also can be used to compare the stability of colour photographs made with different products and to access the effects of processing variations or post-processing treatments. The accuracy of predictions made on the basis of such accelerated ageing tests will depend greatly upon the actual storage or display conditions.

It should also be remembered that density changes induced by the test conditions and measured during and after the tests include those in the film or paper support and in the various auxiliary layers that may be included in a particular product. With most materials, however, the major changes occur in the dye image layers.

Stability when stored in the dark

The tests for predicting the stability of colour photographic images in dark storage are based on an adaptation of the Arrhenius method described by Bard *et al*.[2][3]) and earlier references by Arrhenius, Steiger and others (see References [4], [5] and [6]). Although this method is derived from well-understood and proven theoretical precepts of chemistry, the validity of its application for predicting changes of photographic images rests on empirical confirmation. Although many chromogenic-type colour products yield image-fading and staining data in both accelerated and non-accelerated dark ageing tests that are in good agreement with the Arrhenius relationship, some other types of products do not.

NOTE For example, integral-type instant colour print materials often exhibit atypical staining at elevated temperatures; treatment of some chromogenic materials at temperatures above 80 °C and 60 % RH can cause loss of incorporated high-boiling solvents and abnormal image degradation; and the dyes of silver dye-bleach images deaggregate at combinations of very high temperature and high relative humidity, causing abnormal changes in colour balance and saturation (see Reference [7]). In general, photographic materials tend to undergo dramatic changes at relative humidities above 60 % (especially at the high temperatures employed in accelerated tests) owing to changes in the physical properties of gelatin.

Stability when exposed to light

The methods of testing light stability in this document are based on the concept that increasing the light intensity without changing the spectral distribution of the illuminant or the ambient temperature and relative humidity should produce a proportional increase in the photochemical reactions that occur at typical viewing or display conditions, without introducing any undesirable side effects.

However, because of reciprocity failures that are discussed in this Introduction, this assumption does not always apply. Thus, the accelerated light stability test methods described in this document are valid at the specified accelerated test conditions, but may not reliably predict the behaviours of a given product in long-term display under normal conditions.

Translucent print materials, designed for viewing by either reflected or transmitted light (or a combination of reflected and transmitted light), shall be evaluated as transparencies or as reflection prints, depending on how they will be used. Data shall be reported for each condition of intended use.

This document does not specify which of the several light stability tests is the most important for any particular product.

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Photography — Processed photographic colour films and paper prints — Methods for measuring image stability

1 Scope

This document describes test methods for determining the long-term dark storage stability of colour photographic images and the colour stability of such images when subjected to certain illuminants at specified temperatures and relative humidities.

This document is applicable to colour photographic images made with traditional, continuous-tone photographic materials with images formed with dyes. These images are generated with chromogenic, silver dye-bleach, dye transfer, and dye-diffusion-transfer instant systems. The tests have not been verified for evaluating the stability of colour images produced with dry- and liquid-toner electrophotography, thermal dye transfer (sometimes called dye sublimation), ink jet, pigment-gelatin systems, offset lithography, gravure and related colour imaging systems. If these reflection print materials, including silver halide (chromogenic), are digitally printed, refer to ISO 18936, ISO 18941, ISO 18946, and ISO 18949 for dark stability tests, and the ISO 18937 series for light stability tests.

This document does not include test procedures for the physical stability of images, supports or binder materials. However, it is recognized that in some instances, physical degradation such as support embrittlement, emulsion cracking or delamination of an image layer from its support, rather than image stability, will determine the useful life of a colour film or print material.

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 5-2, *Photography and graphic technology — Density measurements — Part 2: Geometric conditions for transmittance density*

ISO 5-3, *Photography and graphic technology — Density measurements — Part 3: Spectral conditions*

ISO 5-4, *Photography and graphic technology — Density measurements — Part 4: Geometric conditions for reflection density*

ISO 18911, *Imaging materials — Processed safety photographic films — Storage practices*

ISO 18913, *Imaging materials — Permanence — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18913 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

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

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