INTERNATIONAL STANDARD

ISO 8374

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Photography — Determination of ISO safelight conditions

Photographie — Détermination des conditions d'éclairage de sécurité ISO

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 8374 was prepared by Technical Committee ISO/TC 42, *Photography*.

This second edition cancels and replace the first edition (ISO 8374:1986), which has been technically revised.

Annex A forms a normative part of this International Standard.

Introduction

The term “safelight” in photography is used to describe a light source that offers the user sufficient time to perform an operation without producing a detectable change in the photographic characteristics of a sensitized material. Because most sensitized materials are handled under safelight conditions by the manufacturers or users, or both, it was considered desirable to specify a standard method to determine working conditions which are safe for sensitized materials.

It is usually assumed, often incorrectly, that lighting conditions are safe if the density in a simple “fog test” is not changed by these conditions. This is untrue for many materials, particularly for black-and-white and colour papers, where an image area may be more sensitive than an unexposed area. Therefore, an unsafe lighting condition may go undetected if one looks for changes in unexposed areas only. Furthermore, the sensitivity of a sensitized product to a safelight may differ according to whether the safelight exposure is received before or after the practical exposure, and the magnitude or even the direction of this difference may in some cases vary from batch to batch of a given film or paper type.

An additional consideration is the cumulative effect of successive exposures. Depending on the types of exposures and the emulsion formulation of the particular sensitized product, these exposures may be subadditive, additive or superadditive.

Generally, the spectral quality for a safelight is selected as a compromise between the visual response of a partially dark-adapted operator and the spectral response (of the product) to this light. This International Standard is not concerned with this selection.

The object of this International Standard is to define when the exposure (the product of intensity and time) from a safelight has a detectable effect on the image-forming characteristics of a sensitized material. Since virtually all exposures are cumulative, exposure of a material to safelights should be kept to a minimum at all stages of handling (i.e., manufacturing, inspection, camera loading, splicing, processing, printing, etc.).

This International Standard provides a means to isolate and evaluate any given single exposure to safelight irradiation among the several exposures likely to be incurred in the manufacturing and use cycle.

Photography — Determination of ISO safelight conditions

1 Scope

This International Standard specifies the methods for determining the maximum exposure time that a given sensitized material can receive from a given safelight without affecting the quality of the final image. It also specifies the records which shall be maintained for the components of a safelight and its operating environment.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 5-2:2001, *Photography — Density measurements — Part 2: Geometric conditions for transmission density*.

ISO 5-3:1995, *Photography — Density measurements — Part 3: Spectral conditions.*

ISO 5-4:1995, *Photography — Density measurements — Part 4: Geometric conditions for reflection density*.

3 Terms and definitions

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

3.1
additivity
condition wherein the effect of successive exposures received by a sensitized product produces a net photographic effect that is precisely that which would be predicted by a mathematical summation of the individual exposures

3.2
dot value
apparent percentage of an area covered by half-tone dots which is calculated from the relative transmission densities of the area of dots, the solid area, and the area between dots

3.3
geometric mean
the *n*th root of the product of *n* quantities, referring here to the square root of the product of two adjacent safelight exposure values

3.4
half-tone image
image composed of dots at a given screen frequency (number of dots per centimetre) that are varied in size (value) and shape to provide visual tonal gradations

3.5
hard dot
half-tone dot with a sufficiently steep edge gradient such that the dot reproduces reliably in film duplication and in the production of a printing plate

3.6
ISO maximum safelight condition
lighting condition that provides half of that exposure which is the geometric mean between the exposure required to produce the smallest detectable change and the (adjacent) maximum exposure which gives no detectable change, evaluated by use of methods described in this International Standard

3.7
post-exposure
latensification
safelight exposure after a sensitized material receives a normal image-forming exposure

3.8
pre-exposure
hypersensitization
safelight exposure before a sensitized material receives a normal image-forming exposure

3.9
safelight
combination of light source, filter and fixture yielding a specific spectral irradiance, appropriate for handling a particular sensitized material

NOTE In some cases, the source itself may be spectrally correct without the need for a filter.

3.10
safelight filter
spectrally selective absorbing material used with a specified light source to produce the required safelight illumination

3.11
safelight fixture
enclosure for a light source (such as tungsten) that dissipates heat and holds a safelight filter (if either are required)

3.12
safelight irradiance
electromagnetic radiation emanating from a safelight that is incident on a sensitized material

NOTE A sensitized material generally has a spectral sensitivity very different from the human eye. This makes it possible for two safelights of differing spectral-power distributions to give the same “visual appearance” but affect a sensitized material quite differently.

3.13
safelight scale exposure
exposure series using the safelight as the light source

3.14
safetime
length of time that a sensitized product can be exposed to a safelight of a given intensity at a given distance

NOTE This will be any time less than or equal to one-half of the geometric mean between the time required to produce the smallest detectable change and the maximum time which gives no detectable change in a sensitized product, using the test conditions outlined in this International Standard.

3.15
smallest detectable change
smallest difference in the image density or hue that, for a given sensitized product, can be seen in a side-by-side visual examination

NOTE This can alternatively be measured by a densitometer if it has accuracy of density difference and repeatability better than or equal to either 0,005 or 0,5 % of the density, whichever is the greater.

3.16
stop
term referring to a factor of two change in exposure, or a change of approximately 0,3 $\log_{10}$ exposure

3.17
subadditivity
condition wherein the effect of successive exposures received by a sensitized product produces a net photographic effect that is less than that predicted by a mathematical summation of the individual exposures

3.18
superadditivity
condition wherein the effect of successive exposures received by a sensitized product produces a net photographic effect that is more than that predicted by a mathematical summation of the individual exposures

NOTE The phenomenon of superadditivity is demonstrated by most print materials. Method 1 determines at what density a given sensitized material is most sensitive to safelight exposure. In some cases, the material may be most sensitive over a range of densities from fog upwards; in such cases, a simple fog test would be adequate.

4 Maintenance and recording of safelight conditions

A record shall be made of all pertinent data including the safelight source type (e.g. light-emitting diode, electroluminescent panel, tungsten bulb, sodium vapour lamp, etc.), source wattage or milliamp draw, voltage, filter used (if any), approximate age of the filter, type and interior finish (e.g. white, matte black, silvered, etc.) of the safelight fixture, distance from the safelight to the sensitized material, exposure times and processing data. The data for indirect safelight illumination (aimed at walls or ceilings) shall also include the colour and reflectance of the surfaces and appropriate geometrical descriptions.

Once established, the safelight exposure variable shall be maintained by ensuring that proper replacement lamps are used, that filters are not fading, that the distance from the safelight to the sensitized material is maintained, and that the environment has not changed (by painting walls, etc.).

Any changes to the elements described above shall be evaluated individually via methods set forth in this International Standard.

5 Test methods

5.1 Introduction

This clause describes two methods of testing to determine the maximum safelight condition.

— Method 1 (see 5.2): the most general method and the one that shall be used when the safelight/material relationship is unknown. It makes no assumptions regarding

  a) the image density at which safelight exposure produces the maximum effect, and

  b) the order of exposures (safelight and image) that produces the maximum effect.

— Method 2 (see 5.3): intended for use only when the basic relationship between safelight and sensitized material is already known. It is thus useful for *in situ* testing of safelit areas, once Method 1 has yielded the safelight/material relationship. (Method 1 may also be used for *in situ* testing, but it is more cumbersome than Method 2.)

In Method 2, the image exposure is simulated by a uniform exposure that produces the greatest sensitivity to subsequent safelight exposure. (In some cases, the material may be most sensitive over a range of densities from fog upwards; here, Method 2 can be reduced to a simple fog test.) The description in 5.3 includes testing both orders of exposures (safelight then image, and image then safelight); but if the order producing the greatest safelight sensitivity is known, or if only one order is relevant (e.g. in an area where photographic materials are manufactured), the other order may be omitted.

Method 2 can be accomplished using a single sheet of sensitized material, as opposed to Method 1 which requires several sheets.

5.2 Method 1

5.2.1 Principle

Separate samples are subjected to a series of safelight exposures before the image exposure and after the image exposure. The maximum safelight exposure which does not affect the image, and also the exposure required to produce the smallest detectable change, are determined and used to define the "ISO maximum safelight condition". Alternatively, if one has already determined whether a given sensitized product shows the first detectable change in the unexposed areas or in the exposed areas at a particular density, the safelight series may be performed on one sample (Method 2, see 5.3).

5.2.2 Apparatus

5.2.2.1 Step tablet

The use of a transmission step tablet is recommended to create a series of stepped exposures which will provide the range of densities expected in the normal use of the material to be evaluated. For products normally exposed with direct X-rays, the exposure series shall be obtained in a manner appropriate for radiographic films. For products normally exposed to a half-tone pattern, the method specified in annex A shall be initially completed in parallel with Method 1. For subsequent testing, the method showing the most sensitivity (the half-tone method of annex A or the continuous-tone method of the main body of this International Standard) shall be used.

If a step tablet is not available, the following procedure may be substituted for the exposure. Cover one end of the piece of sensitized material being tested with a black card or other opaque material and uniformly flash expose the uncovered area, moving the card to produce a series of exposure times such as 1 s, 2 s, 4 s, 8 s, 16 s, etc. The spectral quality of the illuminant shall be similar to that normally used for the material. The exposures should produce the full range of densities expected in actual use. A less satisfactory alternative is to give the entire piece of sensitized material, except for a protected border, a uniform exposure through a transparent picture image, providing the picture produces a satisfactory distribution of light, medium and dark tones.

It is important to remember that areas receiving lower image exposures are particularly vulnerable to the effects of low-level exposures as might occur under safelight conditions.

5.2.2.2 Opaque cover

A black opaque card is needed to limit the area exposed to the safelight illumination. Additional pieces of card and masking tape may be used in the construction of a guide for positioning the sensitized material and the opaque card in the dark.

5.2.2.3 Timer

A means of timing the exposure from the safelight for a few seconds to 8 min or longer is required. If a visual timer is used, any light provided for or by the timer shall be prevented from reaching the sensitized material, unless such light constitutes part of the normal dark-room safelight illumination being tested.

5.2.3 Test conditions

Samples shall be handled in total darkness except when intended exposures are made. During exposure, to determine the strict "ISO maximum safelight condition", the specimens shall be kept at a temperature of 23 °C ± 2 °C and at a relative humidity of (50 ± 5) %.

For internal purposes, it may be more appropriate to use different and/or less tightly specified conditions of temperature and relative humidity (e.g. ambient conditions, in an *in situ* test). The result obtained under these conditions may be referred to as "maximum safelight condition" but shall not to be referred to as the "ISO maximum safelight condition".

5.2.4 **Procedure** (see Figure 1)

Densities with side covered	Densities with side exposed to safelight
0,10	0,10
0,20	0,25
0,41	0,47
0,85	0,88
1,19	1,21
1,69	1,69

Figure 1 — Typical strip after processing (unsafe condition)

5.2.4.1 Pre-exposure test

Cut the sensitized material to be tested into several strips, preferably at least 2,5 cm wide.

Cover one-half of a strip longitudinally with an opaque card and expose the other half to the safelight illumination for the shortest time considered practical.

Repeat this procedure for each successive strip while increasing the safelight exposure time. For example, expose one strip for 15 s, the next one for 30 s, etc., doubling the time for each successive strip.

In total darkness, make a step-tablet exposure on each strip; it is important that the exposures produce the full range of densities expected in actual use.

Process the strips together in total darkness within 15 min to 45 min of the last exposure in order to minimize latent image keeping effects. The process shall be the same as is normally used for the sensitized material.

5.2.4.2 Post-exposure test

Cut the sensitized material to be tested into several strips, preferably at least 2,5 cm wide.

In total darkness, make a step-tablet exposure on several strips of the sensitized material. It is important that the exposures produce the full range of densities normally expected in actual use.

Cover one-half of a strip longitudinally with an opaque card. Expose the other half to the safelight illumination for the shortest practical time. Repeat this procedure for each successive strip doubling the exposure time.

Process the strips together in total darkness within 15 min to 45 min of the last exposure in order to minimize latent image keeping effects. The process shall be the same as is normally used for the sensitized material.

5.3 Method 2

5.3.1 Principle

All testing shall be performed in total darkness, other than the light being tested. For the sake of efficiency, three separate tests are typically run on one rectangular sheet of sensitized material which is partitioned into thirds across its width (see Figure 2). One third is used for each test.

In the first test, the Uniform Picture Exposure (UPE) precedes the Safelight Scale Exposure (SSE) and is called the "Uniform Picture + Safelight Scale" test.

In the second test, the Safelight Scale Exposure is the only exposure given and it is called the "Safelight Scale" test.

In the third test, the SSE precedes the UPE and is called the "Safelight Scale + Uniform Picture" test.

The sample is processed and examined to determine in which test and at what level on the scale the first detectable change is seen.

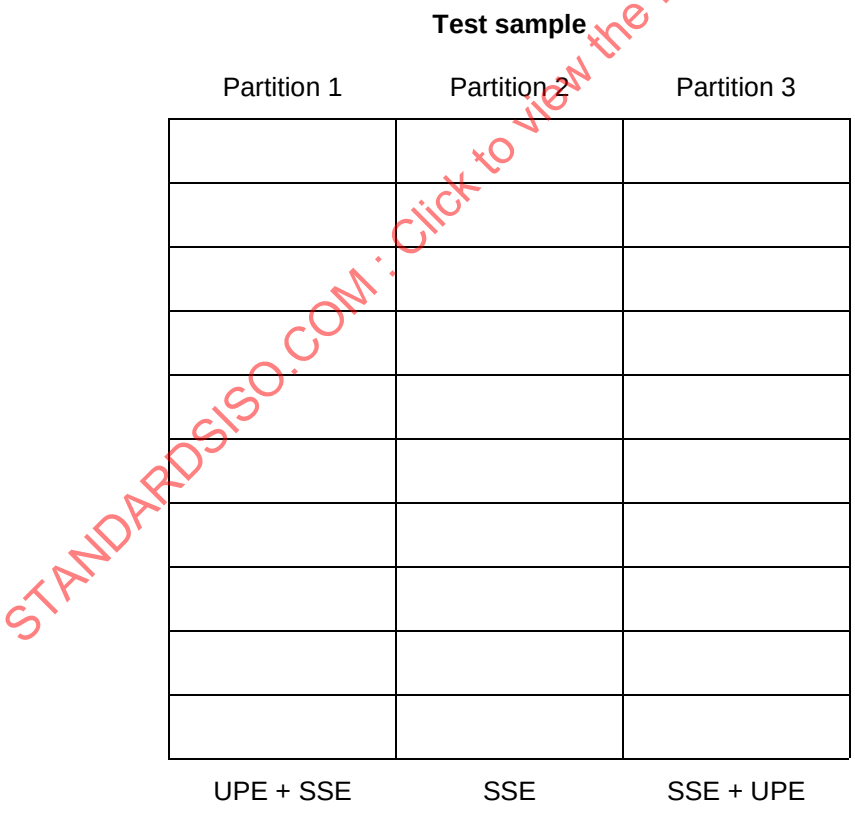


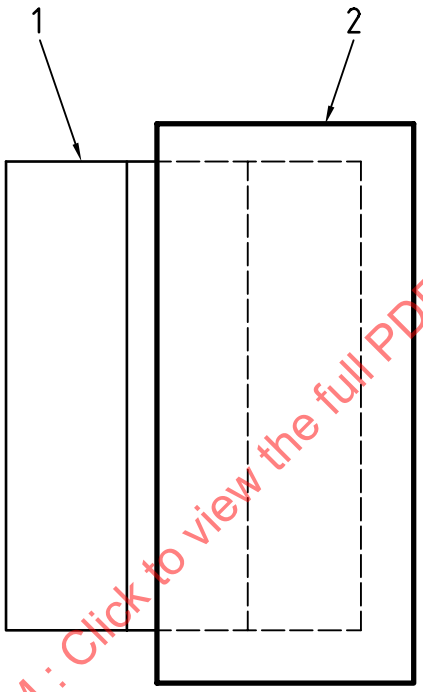
Figure 2 — Format of a three-partition safelight test

5.3.2 Apparatus

5.3.2.1 Partition mask

An opaque mask shall be made that occludes two adjacent “partitions” of the sample as described in 5.3.1 (see Figure 3). This mask shall be used in step a) of the sequence described in 5.3.4. The same mask, in a different position, shall be used in step e) of 5.3.4.

There should be no need to use this mask with films where the pre-, post- or fog exposure tests yield the same “ISO maximum safelight condition”.



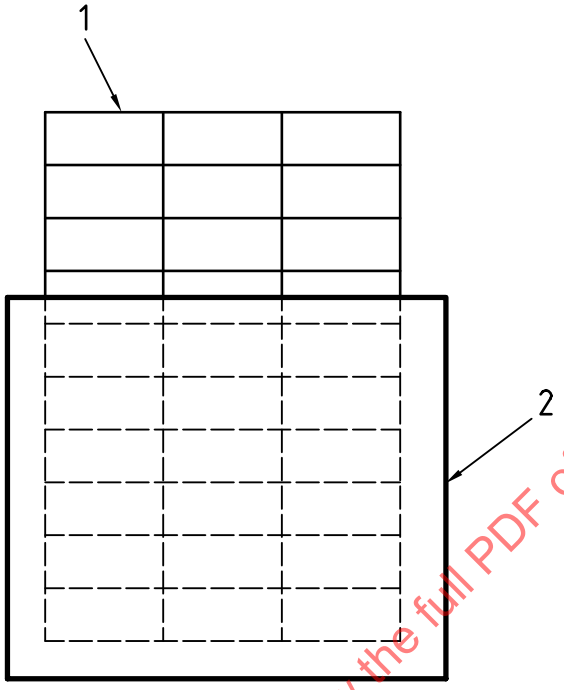
Key

1 Sample
2 Mask

Figure 3 — Partition mask

5.3.2.2 Step mask

An opaque mask or masks shall be made for use in producing the step exposures lengthwise along the product in each partition as described in 5.3.3.2 (see Figure 4).



Key

1 Sample
2 Mask

Figure 4 — Step mask

5.3.3 Procedure

5.3.3.1 Uniform Picture Exposure (UPE)

The goal of this exposure is to expose the test material to yield the density at which the material has the greatest safelight sensitivity. The precise value of this density for the photographic material in question can be determined from Method 1. As a guide, it is usually of the order of 0,3 D above D_{min} for a negative material or 0,5 D below D_{max} for a reversal material, i.e. equivalent to a customer exposure in the toe area of a negative material or the shoulder area of a reversal material.

This density shall be uniform over the area of the test material. Such an exposure can be generated by use of a typical enlarger, or any other light source that can provide a uniform illumination over the sample area. When using an enlarger, either use it with no negative material in the gate, or if attenuation is desired, insert a piece of neutral density filter. The required uniform density is achieved through trial and error using appropriate sensitometric principles and comparing the density of the trial samples with a calibrated grey scale.

As nearly as possible, all layers of a colour product should receive an exposure resulting in equal density above D_{min} (or below D_{max} in a reversal material) because some just detectable safelight exposures involve dye development from more than one layer of product. For achieving the desired balance of layer densities, use the appropriate sensitometric principles and measure the densities of the trial sample with the appropriate geometric and spectral conditions specified in ISO 5-2, ISO 5-3 and ISO 5-4.

For products normally exposed to a half-tone dot pattern (tint pattern) that have been shown to have greater sensitivity to the method specified in annex A than to Method 1, a properly exposed half-tone dot pattern shall be substituted for the UPE. This half-tone dot pattern shall be a uniform field of dots of the dot value showing the greatest sensitivity to safelight exposure (typically 50 %) at a screen ruling of 60 lines per centimetre. The half-tone scale shall be exposed in vacuum contact from a hard-dot tint pattern or by a suitably programmed graphic-arts quality image writing device. The method of evaluation shall be as defined in annex A.

5.3.3.2 Safelight Scale Exposure (SSE)

An optimal exposure series for the safelight should be a range of 8 stops to 12 stops, in 1 stop increments. This can be accomplished by the use of a device that sequentially removes the opaque mask(s) from successive “steps” of the sample (see Figure 4).

The sample should be at a distance from the safelight that meets the dual need of being typical safelight usage and having an irradiance from the safelight that falls uniformly over the surface of the sample. The opaque mask(s) should be removed from successive “steps” of the sample on a time basis such that, when the test is completed, each “step” has received an exposure that is one stop different from adjacent “steps”.

5.3.4 Exposure sequence

Once the UPE and the SSE conditions have been established, the following sequence will produce the desired three tests by using those exposures and the appropriate partition masks.

a) Occlude partitions 2 and 3.

b) Expose partition 1 to the UPE.

c) Uncover all three partitions.

d) Expose all three partitions to the SSE.

e) Occlude partitions 1 and 2.

f) Expose partition 3 to the UPE.

5.3.5 “Uniform Picture + Safelight Scale” test

Following the sequence of exposures given in 5.3.4, partition 1 now has the exposures to produce this test.

5.3.6 “Safelight Scale” test

Following the sequence of exposures given in 5.3.4, partition 2 now has the exposures to produce this test.

5.3.7 “Safelight Scale + Uniform Picture” test

Following the sequence of exposures given in 5.3.4, partition 3 now has the exposures to produce this test.

6 Test method for safelight conditions during processing

First, decide at which point during the process-cycle exposure to the safelight is necessary or desirable. The safetime for a wet sensitized material may be longer or shorter than for the same material in a dry condition. Likewise, any change in the processing time or chemicals can affect the calculated safetime of a given safelight. Hence, the test method must first determine the processing-chemical condition or conditions that are relevant (e.g., push processing of colour reversal films or processing black-and-white papers at 3 min instead of 90 s). The safelight tests described above must be repeated through each of these variable-chemical conditions. Generally, processing times and conditions are set by a machine configuration. However, this precautionary statement is included here to ensure that a scientific method is followed.

The preferred way to evaluate safelight conditions used during processing is to vary the intensity on the sensitized material. This may be done by

a) using a series of area masks, made from a black opaque material, over the safelight fixture, or

b) varying the distance of the safelight fixture from the sensitized material, or

c) introducing non-selective absorbers over the safelight fixture.

In total darkness, make step-tablet exposures on several strips of the sensitized material. Process one strip in total darkness. Process a second strip with the safelight turned on for a specified interval in the process cycle. Decrease the illuminance from the safelight by 50 % and process another strip with the safelight turned on only during the same interval of the process as was used for the second strip. Process additional strips, reducing the illuminance on the material by 50 % for each successive test.

7 Evaluation

7.1 General

A satisfactory test will straddle the range from “no safelight effect” to “significant safelight effect”. In Method 1, this means a series of strips covering this range; in Method 2, it means that a portion of the stepped safelight scale exposures exhibits no safelight effect, the centre step shows a just noticeable effect, and the remaining steps show a significant effect. If this range is not straddled (either no safelight effects visible, or effects on virtually all strips or safelight scale steps), the tests must be repeated with an increased or decreased safelight exposure.

7.2 Subjective (visual) procedure

By a visual comparison with the “no safelight exposure” situation, determine the strips (Method 1) or steps (Method 2) where the transition is made from no detectable change to first detectable change in density. Determine the geometric mean (3.3) exposure time between these two conditions. This exposure time, when divided by a factor of 2, is the time component of the “ISO maximum safelight condition” (other components of the safelight condition are given in clause 4).

Precautions shall be taken to use viewing conditions appropriate for the material. The spectral conditions, geometric conditions, and illuminance levels shall be similar to those normally encountered in product use.

This subjective procedure is not recommended for colour-negative films because the spectral sensitivity of the material on which it is to be printed is normally quite different from that of the human eye.

7.3 Objective (instrumental) procedure

All steps shall be read on a densitometer using the appropriate geometric and spectral conditions as specified in ISO 5-2, ISO 5-3 and ISO 5-4. The step with the smallest detectable change for the four categories under which sensitized products may fall is defined as follows.

a) Reversal products, simple fog test — a drop in maximum density of 0,5 %.

b) Reversal products with picture exposure — a drop in density of 0,5 % of the density of the test area.

c) Negative products, simple fog test — a gain in density of either 0,005 or 0,5 % of the density (whichever is greater) above D_{min}.

d) Negative products with picture exposure — a gain in density of either 0,005 or 0,5 % (whichever is greater) of the density of the test area.

Determine the geometric mean (3.3) between the exposure time associated with the smallest detectable change and the adjacent exposure time associated with no detectable change. This exposure time, when divided by a factor of 2, is the time component of the “ISO maximum safelight condition” (other components of the safelight condition are given in clause 4). All density gains or drops are in reference to an area that is given no safelight exposure. These cited densities may come from any one layer or from the sum of all layers of a product.

8 Designation

The designations “safetime” or “ISO maximum safelight condition”, as defined in clause 3, are applied to the specific sensitized product and safelight arrangements that have been evaluated using the procedures specified in this International Standard. Because these designations are valid for a particular sensitized material only with a particular safelight arrangement, the conditions outlined in clause 4 shall be identified when the designations are quoted.