INTERNATIONAL STANDARD

ISO 8225

First edition
1987-12-15

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
ORGANISATION INTERNATIONALE DE NORMALISATION
МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Photography — Ammonia processed diazo photographic film — Specification for stability

Photographie — Film photographique diazoïque traité à l'ammoniac — Spécification pour la stabilité en conservation

Reference number
ISO 8225 : 1987 (E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8225 was prepared by Technical Committee ISO/TC 42, *Photography*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Photography — Ammonia processed diazo photographic film — Specification for stability

0 Introduction

Since 1930, great advances have been made in the use of photographic films for the preservation of records. The preservation of film records by national, state, and municipal governments, by banks, insurance companies, industry, and other enterprises, has been stimulated by a recognition of the resultant economies in storage space, organization, accessibility, and ease of reproduction. The safe-keeping of pictorial film records having legal, scientific, industrial, medical, historical, military, or other values has also become increasingly important.

The use of film for records having a long-term value necessitated the development of International Standards specifying the characteristics of film suitable for this purpose; ISO 4331 and ISO 4332 specify the requirements for silver-gelatin films which have archival keeping qualities. Archival films have been defined as those suitable for the preservation of records having permanent value. To date, only silver-gelatin type film has been specified as meeting the requirements for archival records. Commercial diazo products do not fall within this category.

However, many users of photographic film are not interested in permanence but in film usability after extended time periods. Accordingly, two additional film categories were defined: "medium-term" and "long-term" film. The standardization of these two additional film categories should increase the utility of this International Standard to a wider spectrum of interested users.

Criteria for properties of medium-term and long-term diazo films are based upon the dark ageing stability of diazo images. Different dark incubation tests are specified for medium-term and long-term film. All other property and processing requirements for medium-term and long-term diazo films are identical.

It is recognized that diazo images may show density changes after exposure to light. However, this International Standard covers only films used as storage copies, not as work copies (as defined in annex B). The light-fading requirements in this International Standard ensure satisfactory behaviour for storage copies which are not intended to be subjected to frequent light exposure.

In addition to the characterization of films with respect to their expected storage life, diazo films are also separated into two classifications (A and B); these classes being dependent upon their intended use. Class A films are those which have density in both the visual and the actinic regions after storage. Such films can be viewed directly or reprinted on to ultraviolet (UV)-sensitive materials. However, some diazo films are manufactured which are not intended to be reprinted on to UV-sensitive materials. Such films require only visual capabilities after storage, and are designated as Class B films. Obviously, both Class A and Class B films can fall into the medium-term and long-term categories. The properties and processing requirements for Class A and Class B films are identical, with the exception of image stability tests after dark ageing and after light fading.

Everyone concerned with the preservation of records on photographic film should realize that specifying the chemical and physical characteristics of the material does not, by itself, assure satisfactory behaviour. It is also essential to provide the correct storage temperature and humidity and protection from the hazards of fire, water, light and certain atmospheric pollutants.

1 Scope and field of application

1.1 This International Standard applies to

— safety cellulose ester base and safety polyester base films which have an ammonia-processed diazo photographic image;

— photographic film in which the image layer is a discrete layer attached to a transparent support or in which the image-forming chemicals are imbibed into a transparent support;

— microfilm, roll film and sheet film.

1.2 The photographic films covered by this International Standard are those intended for medium-term and long-term records.

1.3 This International Standard characterizes only the inherent keeping behaviour of the film covered. However, the suitability of a film record after extended storage depends on both the inherent ageing characteristics of the film and the original image quality. The latter is discussed in annex A.

1.4 This International Standard applies only to photographic diazo film intended and used as medium-term and long-term storage copies. It does not apply to diazo film records intended and used as "work" or "use" copies as discussed in annex B.

2 References

ISO 5, *Photography — Density measurements —*

Part 1: Terms, symbols, and notation.

Part 2: Geometric conditions for transmission density.

Part 3: Spectral conditions.

ISO 1184, *Plastics — Determination of tensile properties of films.*

ISO 4331, *Photography — Processed photographic film for archival records — Silver-gelatin type on cellulose ester base — Specifications.*

ISO 4332, *Photography — Processed photographic film for archival records — Silver-gelatin type on poly(ethylene terephthalate) base — Specifications.*

ISO 5466, *Photography — Practice for the storage of processed safety photographic film.*

ISO 5626, *Paper — Determination of folding endurance.*

ISO 6077, *Photography — Determination of brittleness of photographic film — Wedge brittleness test.*

ISO 7830, *Photography — Safety photographic films other than motion-picture films — Material specifications.*

3 Definitions

For the purpose of this International Standard the following definitions apply.

3.1 medium-term film: A photographic film which is suitable for the preservation of records for a minimum of 10 years when stored under "medium-term" conditions, providing the original images are of suitable quality.

3.2 long-term film: A photographic film which is suitable for the preservation of records for a minimum of one hundred years when stored under "optimum" conditions, providing the original images are of suitable quality.

3.3 archival film: A photographic film which is suitable for the preservation of records having permanent value when stored under "optimum" conditions and providing the original images are of suitable quality.

NOTE — Films suitable for archival records are specified in ISO 4331 and ISO 4332.

3.4 class A films: Films which are usable both visually and for printing on to ultraviolet-sensitive materials.

3.5 class B film: Films which are usable visually but do not have any density requirements for printing on to ultraviolet-sensitive materials.

3.6 film base: The plastic support for the image layers or image-forming chemicals, see annex C.

3.7 safety cellulose ester base: A film base composed mainly of cellulose esters of acetic, propionic, or butyric acids, or mixtures thereof.

3.8 safety poly(ethylene terephthalate) base: A film base composed mainly of a polymer of ethylene glycol and terephthalic acid.

3.9 safety photographic film: Film that meets the specifications with respect to hazard from fire as defined in ISO 7830.

3.10 medium-term storage: Those storage conditions suitable for ensuring a minimum useful life of 10 years for medium-term films.

3.11 optimum storage: Those storage conditions suitable for the preservation of photographic film having permanent value.

NOTE — Optimum storage conditions will prolong the useful life of both archival and non-archival films.

3.12 transmission density: The radiant energy-absorbing quality of a photographic material, expressed as the co-logarithm of the transmittance factor determined for specified geometric and spectral conditions (see ISO 5).

3.13 visual transmission density: A density measurement meeting spectral requirements specified in ISO 5-3 for visual density.

NOTE — The geometric conditions of measurement should also be described.

3.14 printing transmission density: A density measurement of a spectrally non-selective film which will produce the same response on the print material as the film measured (see ISO 5-3). The contact printing density of a film specimen is equal to the transmission density of a spectrally non selective neutral modulator when they both produce the same response on the print material when contact printed together.

4 Physical requirements

4.1 Film base type

The base used for diazo film shall be of a safety cellulose ester type or safety poly(ethylene terephthalate) type and can be identified by the method specified in 7.1.

4.2 Viscosity retention

The relative viscosity of a solution of film base obtained from processed film shall not show a loss which exceeds 5 % as the result of accelerated ageing of the processed film. The accelerated ageing shall be accomplished as specified in 6.2 and the viscosity determined as specified in 7.2.

4.3 Safety requirements

The film shall meet the requirements of the safety film specified in ISO 7830.

4.4 Base physical property loss

4.4.1 Cellulose ester base film

Processed film shall withstand the number of double MIT folds specified in line 1 of table 1 when tested as specified in 7.3. The loss in folding endurance after accelerated ageing, as specified in 6.2, shall not exceed the percentage specified in line 2 of table 1.[1)]

Table 1 — Limits for flexibility and flexibility loss of cellulose ester base film

Characteristic	Total film thickness under 0,13 mm	Total film thickness 0,13 to 0,18 mm
1 Unheated film Minimum permissible average number of double MIT folds	20	10
2 Film after accelerated ageing Maximum permissible average loss in folds	25 %	35 %

4.4.2 Poly(ethylene terephthalate) base film

Processed film shall have a tensile strength and elongation at break as specified in line 1 of table 2 when tested as specified in 7.3. The loss in tensile properties after accelerated ageing, as specified in 6.2, shall not exceed the percentage specified in line 2 of table 2.

Table 2 — Limits for tensile properties and tensile properties loss of poly(ethylene terephthalate) base film

Characteristic	*Tensile* strength at break	Elongation at break
1 Unheated film Minimum permissible tensile properties	138 MPa*	75 %
2 Film after accelerated ageing Maximum permissible loss in tensile properties	10 %	10%

* 1 MPa = 10^6 N/m^2

4.5 Layer adhesion

4.5.1 Tape-stripping emulsion adhesion

The processed film shall not show any removal of the processed image or image layer when tested before and after accelerated ageing. Accelerated ageing shall be accomplished as specified in 6.2, and the emulsion adhesion test shall be performed as specified in 7.4 (see also annex C).

4.5.2 Humidity-cycling emulsion adhesion

The processed image layer shall not show separation or cracking which would impair its intended use when tested as specified in 7.5 (see also annex C).

4.6 Blocking

Processed film shall show no evidence of blocking (sticking), delamination, or surface damage when tested before and after accelerated ageing, as specified in 6.2. Blocking shall be tested as specified in 7.6.

A slight sticking of the film samples which does not result in physical damage or a change in the gloss of the surface shall be acceptable.

4.7 Binder stability

Processed film shall not exceed a 1 mm increase in brittleness after accelerated ageing as specified in 6.2. Brittleness shall be determined at 50 % relative humidity in accordance with ISO 6077.

Films shall be tested in either low-density or high-density areas.

4.8 Thermal sticking

Processed film shall show no evidence of blocking (sticking), delamination or surface damage at high temperatures when tested before and after accelerated ageing as specified in 6.2. Thermal sticking shall be tested as specified in 7.7.

A slight sticking of film to glass which does not result in physical damage shall be acceptable.

5 Image requirements

5.1 Proper development

Processed film shall not show a visual diffuse transmission density decrease greater than 30 % when tested as specified in 8.2.

1) The increase in the limits for percentage fold loss with increase in film thickness is necessary because the test is less precise when the number of folds is small.

5.2 Image stability — Light fading

Low-density and high-density patches of the processed film shall be tested in a light exposure apparatus as described in 8.3. After testing, the low-density patches shall have a diffuse density of 0,4 or less, and the difference between the high-density and low-density patches shall be 0,8 or greater (see table 3). These density requirements shall apply to both visual and type 2 printing densities for class A films and to visual density only for class B films (see annex D).

5.3 Image stability — Dark ageing

Low-density and high-density patches of the processed film shall be incubated as specified in 8.4 using the conditions specified for either medium-term or long-term films. After incubation, the low-density patch shall have a diffuse density of 0,4 or less, and the difference between the high-density and low-density patches shall be 0,8 or greater (see table 3). These density requirements shall apply to both visual and type 2 printing densities for class A films and to visual density only for class B films.

Table 3 — Limits for image diffuse density change after accelerated testing*

	Medium-term film and long-term film
Original diazo density levels	
Low density	0,10 ± 0,05
High density	1,2 ± 0,1
Final diazo density levels**	
Low density	**⩽ 0,4**
High density — Low density	**⩾ 0,8**

* These requirements apply to both visual and type 2 printing densities for class A films and to visual density only for class B films.

** After the light fading test (see 8.3) or the dark ageing test (see 8.4).

6 Accelerated ageing

6.1 General

Processed film shall be subjected to the following accelerated ageing conditions when determining whether it meets the requirements specified in clause 4 for viscosity retention, base physical property retention, tape-stripping emulsion adhesion, blocking, binder stability and thermal sticking.

6.2 Accelerated ageing conditions

The processed test samples shall be mounted in a sample rack so that they are freely exposed to the surrounding air. The rack shall then be placed in a glass laboratory desiccator jar. The jar shall be heated in a forced-air circulating oven for 72 h at 100 ± 2 °C. The atmosphere within the jar shall be maintained at 20 % relative humidity. This relative humidity can be obtained by keeping a saturated solution of potassium acetate in water at the bottom of the jar.[1)] Care shall be exercised to ensure that the saturated solution contains an excess of undissolved crystals at 100 °C. The undissolved crystals shall be completely covered by the saturated salt solution and the surface area of the solution should be as large as practical. The jar and the salt solution shall be maintained at 100 °C for at least 20 h prior to use to ensure adequate equilibrium.

Alternatively, exposure to these temperatures and humidity conditions may be provided by means of a conditioning air cabinet. The samples shall be suspended to keep them separated from each other. No other materials shall be in the same environment as the test samples during the heating period.

In subsequent sub-clauses, specimens subjected to these accelerated ageing conditions are designated "heated specimens".

7 Physical test methods

7.1 Identification of film base

All emulsion, backing and sublayers shall be removed from a specimen of the unknown film by scraping. A sample of the base material shall then be prepared by scuffing the surface with a suitable tool to produce a very fine powder. This powder shall be mixed in a mortar with about 100 times its mass of potassium bromide previously ground to about 75 µm. A strip or pellet shall be prepared [1]. An infra-red absorption curve shall be obtained from this pellet by means of an infra-red absorption spectrometer. The identity of the unknown base can be established by comparison with curves for known polymers [2].

7.2 Relative viscosity test

Measurements shall be made on two unheated specimens of processed film having the same average photographic density. The emulsion and any backing layers shall be removed by scraping before proceeding with the relative viscosity determination. Each sample of base without coatings shall have a mass of 1,00 g. Each specimen shall be treated as follows:

If the film base is a cellulose ester as determined by 7.1, each specimen shall be immersed in a separate 100 ml one mark volumetric flask containing approximately 95 ml of a mixture of 90 % (m/m) methylene chloride and 10 % (m/m) methanol.

WARNING — Methylene chloride is toxic by inhalation, contact with skin and if swallowed. Do not breathe vapours. Avoid contact with skin.

The base may be dissolved by repeated shaking for 1 to 2 h or by allowing the mixture to stand overnight.

1) The relative humidity is based on the nominal vapour pressure of the salt solution but the relative humidity tolerances cannot be specified.

If the film base is poly(ethylene terephthalate) as determined by 7.1, it can be dissolved in approximately 95 ml of a mixture of 60 % (m/m) phenol and 40 % (m/m) chlorobenzene by mass.

WARNING — Phenol chlorobenzene mixture causes severe burns, is toxic by inhalation, contact with skin and if swallowed. Do not breathe vapours. After contact with skin, wash immediately with plenty of water. Do not pipette by mouth.

Prepare the mixture of phenol and chlorobenzene by stirring the molten phenol into the chlorobenzene. Use hot solutions in a fume cupboard.

The base may be dissolved by repeated shakings or strirring for 15 min in an oil bath at 140 ± 1 °C.

Immerse the flasks containing the dissolved film base in a water bath maintained at 25 ± 1 °C until temperature equilibrium has been reached. Add solvent to adjust the volume of the solution to 100 ml, and thoroughly mix the contents. Transfer a portion of the liquid, by filtration[1] if necessary, to an Ostwald pipette or an equally suitable capillary viscometer immersed in a constant-temperature bath at the same temperature.

WARNING — These solutions are toxic by inhalation, contact with skin and if swallowed. Use a water pump or vacuum pump to draw these solutions into pipettes.

The pipette chosen shall have a flow time between 70 and 110 s for the solvent. The volume taken shall be sufficient to fill half the lower bulb of the pipette. Measure the time of flow of the solution through the capillary of the pipette to the nearest 0,2 s. Repeat the measurement for the same volume of the pure solvent. Make three readings for each portion. The relative viscosity is the ratio of the average flow time of the solution to that of the solvent. Duplicate determinations shall be made on both the unheated and heated specimens and the averages shall be calculated separately.

7.3 Base physical property loss

7.3.1 Sample preparation

Processed film in 16 mm form may be tested in this width. Films in other sizes shall be cut 15 to 16 mm wide and at least 12 cm long, using a sharp tool which does not nick the edges of the sample. Ten specimens are required for unheated film and ten specimens for film heated as specified in 6.2. The unheated and heated specimens shall be cut alternately and continuously from a single piece of film.

7.3.2 Conditioning

All specimens, both unheated and heated, shall be conditioned at 23 ± 2 °C and (50 ± 2) % relative humidity for at least 15 h. This may be accomplished by means of an air-conditioned room or a conditioning air cabinet. The specimens shall be supported in such a way as to permit free circulation of air around the film and the linear air velocity shall be at least 15 cm/s.

7.3.3 Procedure

The film specimens shall not be removed from the conditioning atmosphere for testing. The unheated and heated specimens shall be tested alternately, and the averages shall be calculated separately.

The cellulose ester base films shall be tested for folding endurance using the MIT folding tester as described in ISO 5626.

The poly(ethylene terephthalate) base films shall be tested for tensile strength and percentage elongation at break as specified in ISO 1184. The thickness of each specimen shall be measured to the nearest 0,002 mm and the width to the nearest 0,1 mm.

7.4 Tape-stripping adhesion test

7.4.1 Specimen preparation

Although the dimensions of the processed film specimen are not critical, one dimension shall be at least 15 cm. Measurements shall be made on two specimens of unheated, processed film and on two heated specimens.

7.4.2 Conditioning

Specimens shall be conditioned as specified in 7.3.2.

7.4.3 Procedure

The film specimens shall not be removed from the conditioning atmosphere for testing. Apply a strip of pressure-sensitive, plastic-base, adhesive tape about 15 cm long to the surface of the processed film. Press the tape down with thumb pressure to ensure adequate contact, leaving enough tape at one end to grasp. No portion of the tape shall extend beyond the edges of the film or cover areas of the film perforations. While holding the film firmly on a flat surface rapidly remove the tape from the film surface by peeling the tape back on itself and pulling the end so that it is removed from the film at an angle of approximately 180°. Removal by the tape of any portion of the surface layer on any of the specimens shall be considered failure.

The results of the tape-stripping test may be very dependent upon the adhesive tape used if the bonding force between it and the particular film surface under test is not sufficiently high. For this reason, a minimum bonding force is specified for this test. Determine this bonding force by applying the adhesive tape to the film surface, in the same manner as specified in the tape-stripping test, and peeling it back rapidly from the film surface at an angle of approximately 180°. Measure the peel-back force required to separate the tape from the film by use of a strain gauge or a maximum-reading spring scale. A bonding force of at least 4 N per centimetre of tape width is required.

1) Filtration has to be rapid to avoid solvent loss. This may be accomplished by filtering through a porous glass-wool pad.

7.5 Humidity-cycling adhesion test

7.5.1 Specimen preparation

A specimen 5 cm square or 5 cm by the film width is convenient, but the dimensions are not critical. Two specimens of processed film shall be selected from a high-density area.

7.5.2 Procedure

Mount the specimens in a rack and place in a glass laboratory desiccator jar so that they are freely exposed to the atmosphere. Place the jar for 8 h in a forced-air circulating oven maintained at 50 ± 2 °C. The atmosphere within the jar shall be maintained at 96 % relative humidity, which can be obtained by keeping a saturated solution of potassium sulfate in water [3] in the bottom of the jar.[1)] After 8 h, place the rack for 16 h in a second desiccator jar in the same oven. The atmosphere within this second jar shall be maintained at 11 % relative humidity, which can be obtained by keeping a saturated solution of lithium chloride in water [3] in the bottom of the jar.[1)] The precautions specified in 6.2 shall be taken to ensure that the proper humidity is obtained.

Time periods of 8 h at the high humidity and 16 h at the low humidity shall constitute one cycle.[2)] Subject the film to 12 humidity cycles, after which remove from the rack and examine the emulsion layer for peeling, flaking, or cracking.[3)] Examine the film under the same magnification and lighting conditions as normal for product use. During a weekend interruption in the cycling procedure, the film shall be kept at 50 ± 2 °C and 11 % relative humidity.

7.6 Blocking test

At least five specimens of processed film shall be conditioned to 62 % relative humidity at 40 ± 2 °C. A specimen size of 5 cm square is convenient where the size of the film permits, but the dimensions are not critical, provided all specimens are of uniform size.

Place the specimens in a glass laboratory desiccator jar so that they are freely exposed to the required conditioning atmosphere for at least 15 h. Put the jar containing the samples into a forced-air circulating oven at 40 ± 2 °C. A relative humidity of approximately 62 % can be obtained by keeping a saturated solution of sodium nitrite [4] in water at the bottom of the jar. The precautions specified in 6.2 shall be taken to ensure that the proper humidity is obtained.

After moisture equilibrium is attained, remove the jar from the oven without removing the specimens from the jar, and stack at least five specimens on a smooth surface so that the image surface of one specimen is against the back surface of the adjacent one. Place the stack under a uniform pressure of 35 kPa. This may be accomplished by placing a weight on the film stack, the dimensions of the weight being greater than those of the film specimens. Replace the jar containing the weighted stack in the forced-air circulating oven for 3 days at 40 °C. Alternatively, exposure to the conditions of temperature and humidity may be provided by means of air-conditioning cabinets or rooms.

Remove the film stack from the oven and allow to cool. Then remove individually the film specimens from the stack and observe for evidence of film blocking (sticking).

7.7 Thermal sticking test

Measurements shall be made on two unheated specimens of processed film and on two heated specimens as specified in 6.2. A specimen 5 cm square is convenient, but the dimensions are not critical.

Place each specimen between two smooth uncoated glass plates that have dimensions slightly larger than the film. Place the film under a uniform pressure of 35 kPa. This may be accomplished by placing a weight on the upper glass plate, the dimensions of the weight being greater than that of the film sample. Place each glass-plate film sandwich into a forced-air circulating oven for 1 h at 65 ± 2 °C.

Remove the glass-plate film sandwich from the oven and allow to cool. Separate the glass plates from the film and observe for evidence of blocking (sticking), film delamination, and surface damage.

8 Image test methods

8.1 Densitometry

Image density shall be measured as specified in 8.1.1 and 8.1.2.

8.1.1 Visual density

ISO standard visual diffuse transmission density shall be measured using a densitometer with the geometric requirements specified in ISO 5-2 and the spectral requirements specified in ISO 5-3.

8.1.2 Printing density

ISO type 2 printing transmission density shall be determined as specified in ISO 5-2 and ISO 5-3 and designated as D_T (90° *opal*; S_H : $\leqslant$ 10°; s_2).

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1) The relative humidity is based on the nominal vapour pressure of the salt solution but the relative humidity tolerances cannot be specified.

2) This can be most easily accomplished by placing the samples in the 96 % relative humidity jar in the morning and the 11 % jar in the evening.

3) Films may sometimes exhibit small pinholes in the image after processing. These can be caused by dirt or dust particles on the emulsion surface at the time raw film is exposed and should not be confused with holes or cracks in the emulsion layer. The existence of such pinholes in the image prior to humidity cycling should be noted so that their presence does not lead to false interpretation of an adhesion weakness.

8.2 Proper development test

ISO visual diffuse transmission density shall be measured after development [5]. Before measuring, the diazo film shall be conditioned for at least 5 min at room temperature in the dark.

Read the type 2 printing density, of an identified area of the processed diazo film having a visual density equal to or greater than 1,00. Place the specimen at a distance of 100 mm from a 100 W clear incandescent lamp for a 10 min exposure. Read the density of the identified area again for printing density. Any density decrease shall be expressed as a percentage of the original density.

8.3 Image stability — Light fading test

Tests shall be made on low-density and high-density areas of two or four specimens of the processed test film. Class A films shall be tested using a pair of specimens measured for visual density and another pair of specimens measured for type 2 printing density. Class B films shall be tested using only one pair of specimens measured for visual density. The low-density area shall be 0,10 ± 0,05 and the high-density area shall be 1,2 ± 0,1 (see table 3) (these densities are typical of diazo microfilm copy).

Insert the specimens in a light exposure apparatus[1]. Position the holders in the light exposure apparatus so that the emulsion side of the specimens is facing the arc. Expose the film for 8 h with the light exposure apparatus operating between 40 % and 50 % relative humidity and at a black-body temperature between 50 and 55 °C. Measure the density values of the low-density and high-density samples using the appropriate methods specified in 8.1.

8.4 Image stability — Dark ageing test

Tests shall be made on low-density and high-density areas of two or four specimens of the processed test film. Class A films shall be tested using a pair of specimens measured for visual density and another pair of specimens measured for type 2 printing density. Class B films shall be tested using only one pair of specimens measured for visual density. The low-density area shall be 0,10 ± 0,05 and the high-density area shall be 1,2 ± 0,1 (see table 3) (these densities are typical of diazo microfilm copy).

Condition the film at (50 ± 2) % relative humidity as specified in 7.3.2. Seal the film in a moisture-proof, metallic-foil envelope. Heat the medium-term films for 14 days at 70 ± 2 °C and the long-term films for 50 days at 80 ± 2 °C [6]. Measure the density value of the low-density and high-density samples using the appropriate methods specified in 8.1.

9 Classification for reporting

Ammonia-processed diazo films shall be classified as medium-term or long-term films, depending upon their useful life. This is determined by the image stability—dark ageing test requirements specified in 5.3. All other property requirements are the same for both classes.

Ammonia-processed diazo films shall be classified as Class A films if they meet visual and printing diffuse density requirements at the end of their projected useful life. They shall be classified as Class B films if they meet visual requirements only. This is determined by the light fading test requirements specified in 5.2 and the dark ageing test requirements specified in 5.3. Other property requirements are the same for both classes.

1) The light exposure apparatus should contain a carbon arc which should be of the solenoid activated type operating at a potential of 120 to 145 V at 15 A. The arc is enclosed in a borosilicate glass globe which filters out wavelengths below 275 nm. The arc should have an irradiance of 1,7 — 5 — 2 W/mm^2 at wavelengths of 358 — 386 — 416 nm respectively and 0,25 W/mm^2 over the rest of the spectrum. Details on the availability of such an arc may be obtained from the ISO Central Secretariat. (Arcs with equivalent transmission may be used.)

Annex A

Microfilm image quality

(This annex does not form part of this International Standard.)

A.1 General

If satisfactory image quality is to be retained after storage, the quality of the image to be stored is as important as the keeping characteristics of the stored film. Considerable attention and care should be taken to ensure that the original camera film is correctly exposed, processed and then correctly printed on to the duplicate film.

In establishing a microfilm system, three factors should be considered: quality of original document, exposure of the document and image contrast.

A.2 Quality of original document

A.2.1 General

The three most important qualities of the original document related to image quality are

a) the height of the characters;

b) the stroke width forming the smallest significant character or line, and

c) for non-computer output microfilm the contrast between the paper and ink.

A.2.2 Character height

The quality requirements needed to enable a micro-recording system to record a character of a specific size in a document can be estimated by use of a "quality index". The quality index (QI) [7] relates the reduction ratio and the resolving power of the system to the height of the smallest significant characters in the document in such a way that the level of legibility in the resulting images can be predetermined.

In most duplicating processes, there is a loss of information with each succeeding generation. It is, therefore, essential that the QI of the camera film be high enough so that the QI of the next generation or generations, including hard-copy printouts, will be sufficient to provide images with adequate legibility for storage [7, 8].

A.2.3 Line or stroke width

Due to optical limitations in most photographic systems, film images of thin lines appearing in the original document will tend to fill in as a function of their width and density. Therefore, as the reduction ratio of a given system is increased, it may be necessary to reduce the background density to achieve an image with relatively low line density so that the copies produced will contain legible characters. No firm rule can, at this time, be given for this relationship.

A.2.4 Ink/paper contrast

With good clear black type on a white background, an image with a high quality index and high contrast can be achieved at a high reduction ratio. As the original print quality and contrast decreases, the reduction ratio or background density, or both, should be decreased to achieve the same quality image unless the resolving power of the system is increased. Bibliographic reference [7] gives the recommended background density for achieving satisfactory images.

A.3 Exposure of the document

A.3.1 General

The second important factor to be considered when photographing documents is exposure control.

It is desirable that the contrast of all images in a single roll or microfiche have the same value to facilitate duplicating; thus permitting constant printing exposure and speed. Due to the wide variety of documents that have to be filmed and the various methods by which they are filmed, compromises have to be made in controlling the exposure. Bibliographic reference [7] gives recommended background densities for camera films based on the contrast of the original documents when using planetary cameras. The same recommendations also apply to rotary cameras. However, even with automatic exposure controls the image densities from rotary cameras cannot be controlled as well as those of planetary cameras. Computer output microfilmers use higher contrast films resulting in more uniform and higher contrast images which facilitates duplicating [8, 9, 10, 11, 12].

A.4 Image contrast

The third factor to be considered when photographing documents, the contrast of the micro-reproduction system, [10] is dependent upon the selection of the correct photographic materials for use in each generation. This applies to both the exposure of the camera film as well as subsequent printing on to the duplicating film.

The average individual who uses microfilm thinks of contrast as the magnitude of the difference in transmittance between the light and dark areas in a microfilm image. From the user's point of view, this is a logical interpretation of contrast. However, the quality of a microfilm image depends on more than the two ends of the scale; it also depends on the ability of the photographic materials to differentiate between small differences in tones in the document. The characteristics curves of the photographic film define the contrast of the reproduction. Cascading of the characteristics curves of all films used in the system produces its tone-reproduction curve. In a microfilm system, the contrast of the tone-reproducing curve affects the quality of the microfilm reproduction. If the contrast in the image is too high, fine lines and light lines from the original document will tend to fill in and bold black lines from the same original will spread. Open areas in certain characters will also fill in. On the other hand, if the contrast is too low, all the graphic information will be reproduced but the lines will appear unsharp and the reproduction will have a flat, muddy appearance.

Film manufacturers have made camera and print films with contrast designed to work effectively together. However, it is up to the user to select the correct films to use in his particular system.

Annex B

Distinction between film storage copies and work copies

(This annex does not form part of this International Standard.)

The distinction between photographic film records which are intended for storage and those intended for use has not always been clear. Use or work copies are the predominant photographic records found in libraries and records centres. Their value lies in their being available for ready reference. However, as a result of this use, they are subjected to dirt, abrasion, fingerprints, contamination with foreign materials and exposure to excessive light and temperatures. Such copies may become conditioned to the moisture conditions of the working area, which may be quite different from those of the storage area where they are filed. In fact, physical distortion of use copies can occur if they are not reconditioned to the moisture conditions of the storage area. It is, therefore, evident that use copies of photographic records are not suitable for long-term preservation.

Where there is a need for extended storage of film records, duplicate storage copies should be prepared and kept in a collection area separate from the ones in which work copies are stored. Storage copies should meet the appropriate ISO requirements for the photographic material used as outlined in this International Standard and its companion documents, ISO 4331 and ISO 4332. It is equally important that storage copies should be stored according to the recommendations of ISO 5466. Of vital importance is the control of temperature and humidity and the protection of the film from dirt and impurities. Unless the appropriate film materials are stored according to recommended procedures, satisfactory preservation will not be obtained. Storage records will occasionally be looked at, otherwise the need for keeping these records is pointless. However, the use of storage copies should be infrequent. If more than infrequent use is required, duplicate work copies should be printed from the storage copies.

In conclusion, there are two types of film records: those intended for use purposes and those intended for the preservation of information. This International Standard pertains to the latter only.

Annex C

Cellulose ester and polyester bases

(This annex does not form part of this International Standard.)

Ammonia-processed diazo films are manufactured on both cellulose ester and polyester bases. Many cellulose-ester-base films have the diazo dyes imbibed into the base itself, thus making the emulsion adhesion tests specified in 7.4 irrelevant. The polyester base films have the advantage of a very high tensile strength and resistance to tearing, providing them with excellent durability.