INTERNATIONAL STANDARD

ISO 9718

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Photography — Processed vesicular photographic film — Specifications for stability

Photographie — Film photographique vésiculaire traité — Spécifications relatives à la stabilité

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Contents

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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.

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.

International Standard ISO 9718 was prepared by Technical Committee ISO/TC 42, *Photography*.

This second edition cancels and replaces the first edition (ISO 9718:1991), which has been technically revised.

Annex A forms an integral part of this International Standard. Annexes B, C, D, E, F, G and H are for information only.

Introduction

Since 1930, great advances have been made in the use of photographic films for the preservation of records. The preservation of records on film by national, state and municipal governments, by banks, insurance companies, industry and other enterprises, has been stimulated by 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 long-term values necessitated the development of International Standards to specify the characteristics of film suitable for this purpose. ISO 10602 specifies the requirements for silver-gelatin films which are suitable for storage. This International Standard (for vesicular film) and ISO 8225 (for diazo film) give the requirements for photographic duplicate films suitable for storage.

The term "archival film" has been discontinued and the new concept of "life expectancy" is introduced. Film life is classified by the LE or life expectancy rating as defined in this International Standard. For example, LE-100 represents film with a life expectancy of 100 years when stored under extended-term storage conditions specified in ISO 5466.

Criteria for properties of LE-10 and LE-100 vesicular films are based upon the dark-ageing stability of D_{min} processed areas. Different dark-incubation tests are specified for LE-10 and LE-100 films but all other properties and processing requirements are identical.

In addition to tests to ensure that the density of D_{min} areas does not increase to unacceptable levels during storage, a test is also specified on high-density areas. This is to guard against the possibility of vesicle (or bubble) collapse during storage. This test has to be carried out at temperatures below the softening point of the image binder, as tests above this temperature have no practical meaning (see references [1, 2]. However, to give confidence of acceptable image stability, the permissible density change was made very small at the measurement error of the densitometer. Both LE-10 and LE-100 vesicular films must meet the same requirement.

It is recognized that vesicular 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 C). The light-fading requirements specified 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, vesicular films are also separated into two classes (A and B); these classes are dependent upon their intended use. Class A films are those which retain density in both the visual and actinic region (printing) after storage. Such films can be viewed directly or reprinted onto ultra-

violet (UV)-sensitive materials. However, some films are not intended to be reprinted onto 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 LE-10 and LE-100 categories. The requirements for Class A and Class B films are identical, with the exception of change in the D_{min} area 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. Conditions for the storage of record films are specified in ISO 5466 and ISO 10214.

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Photography — Processed vesicular photographic film — Specifications for stability

1 Scope

1.1 This International Standard establishes specifications for the stability of polyester-base safety film which has a heat-processed vesicular photographic image formed by nitrogen bubbles. It covers photographic film intended for LE-10 and LE-100 records.

1.2 This International Standard applies to photographic film in which the image layer is a discrete layer attached to a transparent support.

1.3 It applies to roll film and sheet film.

1.4 This International Standard characterizes only the inherent keeping behaviour of the film. 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 B.

1.5 This International Standard applies only to vesicular photographic film intended and used as LE-10 and LE-100 storage copies. It does not apply to vesicular film records intended and used as "work" or "use" copies (as discussed in annex C). Most film records used in libraries are work copies and have to be durable. LE-10 and LE-100 storage copies should be stored in accordance with ISO 5466 and ISO 10214. The effects of heat and pressure are discussed in annex D and those of high humidity in annex E.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5-1:1984, *Photography — Density measurements — Part 1: Terms, symbols and notations.*

ISO 5-2:1991, *Photography — Density measurements — Part 2: Geometric conditions for transmission density.*

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

ISO 527-3:1995, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets.*

ISO 543:1990, *Photography — Photographic films — Specifications for safety film.*

ISO 5466:1992, *Photography — Processed safety photographic films — Storage practices.*

ISO 6077:1993, *Photography — Photographic films and papers — Wedge test for brittleness.*

ISO 8225:1995, *Photography — Ammonia-processed diazo photographic film — Specifications for stability.*

ISO 10214:1991, *Photography — Processed photographic materials — Filing enclosures for storage.*

ISO 10602:1995, *Photography — Processed silver-gelatin type black-and-white film — Specifications for stability.*

3 Definitions

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

3.1 archival medium: Recording material that can be expected to retain information for ever so that it can be retrieved without significant loss when properly stored.

NOTE 1 There is, however, no such material and it is not a term to be used in International Standards or system specifications.

3.2 life expectancy (LE): Length of time that information is predicted to be retrievable in a system under extended-term storage conditions.

NOTE 2 However, the actual useful life of film is very dependent upon the existing storage conditions (see ISO 5466 and ISO 10214).

3.3 LE designation: Rating for the "life expectancy" of recording materials and associated retrieval systems. The number following the LE symbol is a prediction of the minimum life expectancy, in years, for which information can be retrieved without significant loss when stored under extended-term storage conditions.

NOTE 3 For example, LE-100 indicates that information can be retrieved for at least 100 years' storage.

3.4 extended-term storage conditions: Storage conditions suitable for the preservation of recorded information having permanent value.

3.5 medium-term storage conditions: Storage conditions suitable for the preservation of recorded information for a minimum of 10 years.

3.6 film base: Plastic support for the emulsion and backing layers.

3.7 emulsion layer(s): Image or image-forming layer(s) of photographic films, papers and plates.

3.8 Class A films: Films which are usable both visually and for printing onto ultraviolet-sensitive materials.

3.9 Class B films: Films which are usable visually but do not have any density requirements for printing onto ultraviolet-sensitive materials.

3.10 safety photographic film: Photographic film which passes the ignition time test and burning time test as specified in ISO 543.

3.11 safety poly(ethylene terephthalate) base: Film base composed mainly of a polymer of ethylene glycol and terephthalic acid.

3.12 density: Degree of light absorption, reflection or scattering characteristics of a photographic image, expressed as the logarithm to the base 10 of the ratio of incident radiant flux to the transmitted, reflected or scattered flux. (See ISO 5-3.)

3.13 printing density: Density of a processed photographic image in which the incident and transmitted radiant flux are evaluated by a receiver having the same spectral response as the photographic material on which the sample is to be printed, and the incident radiant flux has the same spectral energy distribution as the printing light source.

3.14 visual diffuse density: Density of a processed photographic image in which the incident and the transmitted or reflected radiant flux are evaluated by the human eye, or by a receiver having the same spectral response as the human eye.

3.15 projection density: Density of a processed photographic image in which the angular distribution of the incident and transmitted radiant flux are equal and specified.

NOTE 4 For microfilm applications, the angular distribution is a nominal half-angle of 6,4°, which corresponds to an *f*-number of *f*/4,5 and simulates a microfilm reader.

4 Safety and hazards

4.1 Hazard warnings

Some of the chemicals specified in the test procedures are caustic, toxic or otherwise hazardous. Safe laboratory practice for the handling of chemicals requires the use of safety glasses or goggles, rubber gloves and other protective apparel such as face masks or aprons where appropriate. Specific danger notices are given in the text and footnotes for particularly dangerous materials, but normal precautions are required during the performance of any chemical procedure at all times. The first time that a hazardous material is noted in the test procedure section, the hazard will be indicated by the word "DANGER" followed by a symbol consisting of angle brackets "⟨ ⟩" containing a letter which designates the specific hazard. A double bracket "⟨⟨ ⟩⟩" will be used for particularly perilous situations. In subsequent statements involving handling of these hazardous materials, only the hazard symbol consisting of the brackets and letter(s) will be displayed. Furthermore, for a given

material, the hazard symbol will be used only once in a single paragraph.

Detailed warnings for handling chemicals and their diluted solutions are beyond the scope of this International Standard.

Employers shall provide training and health and safety information in conformance with legal requirements.

The hazard symbol system used in this International Standard is intended to provide information to the users and is not meant for compliance with any legal requirements for labelling as these vary from country to country.

It is strongly recommended that anyone using these chemicals obtain from the manufacturer pertinent information about the hazards, handling, use and disposal of these chemicals.

4.2 Hazard information code system

⟨B⟩ Harmful if inhaled. Avoid breathing dust, vapour, mist or gas. Use only with adequate ventilation.

⟨C⟩ Harmful if contact occurs. Avoid contact with eyes, skin or clothing. Wash thoroughly after handling.

⟨S⟩ Harmful if swallowed. Wash thoroughly after handling. If swallowed, obtain medical attention immediately.

⟨⟨S⟩⟩ May be fatal if swallowed. If swallowed, obtain medical attention immediately.

⟨F⟩ Will burn. Keep away from heat, sparks and open flame. Use with adequate ventilation [1].

⟨O⟩ Oxidizer. Contact with other material may cause fire. Do not store near combustible materials.

4.3 Safety precautions

All pipette operations shall be performed with a pipette bulb or plunger pipette.

Safety glasses shall be worn for all laboratory work.

5 Requirements for film base

The base used for record film, as specified in this International Standard, shall be of a safety polyester [i.e. poly(ethylene terephthalate)] and can be identified by the method described in 9.1.

Some films on polyester base can have a maximum LE rating of 500.

6 Requirements for processed film

6.1 Safety film

The film shall meet the requirements specified in ISO 543.

6.2 Amount of free acid

The polyester base shall not have an amount of free acid greater than the equivalent of 1,0 ml of 0,1 mol/l sodium hydroxide solution per gram of film. The amount of free acid shall be measured in accordance with 9.3.

The volume of 0,1 mol/l sodium hydroxide equivalent to the amount of free acid of the processed film shall not increase more than 0,5 ml over its original value after the accelerated ageing described in 9.2.

6.3 Tensile properties and loss in tensile properties

The film samples shall be processed and dried under the conditions used for the film records. Processed films shall be tested for tensile properties as described in 9.4 and shall have a tensile stress and elongation at break as specified in table 1 (unheated film). The loss in tensile properties after accelerated ageing as described in 9.2 shall not exceed the percentage specified in table 1 (heated film).

1) The flammable warning symbol ⟨F⟩ will not be used for quantities of common solvents under 1 litre.

Table 1 — Limits for tensile properties and loss in tensile properties on accelerated ageing of polyester-base film

Film type	Tensile stress at break	Elongation at break
Unheated film Minimum permissible tensile properties	140 MPa [1]	75 %
Heated film Maximum permissible loss in tensile properties compared with unheated film	15 %	30 %

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

7 Requirements for the emulsion and backing layers of processed film

7.1 Layer adhesion

7.1.1 Tape-stripping adhesion

The processed film shall not show any removal of the emulsion layer or backing layer when tested as described in 9.5.

7.1.2 Humidity-cycling adhesion

The emulsion layer or backing layer of the processed film shall not show separation or cracking that can impair its intended use, when tested as described in 9.6.

7.2 Blocking

Processed film shall show no evidence of blocking (sticking), delamination or surface damage when tested as described in 9.7. A slight sticking of the film samples that does not result in physical damage or a change in surface gloss shall be acceptable.

7.3 Binder stability

Processed film shall not exceed a 1 mm increase in brittleness after accelerated ageing as specified in 9.2. Brittleness shall be determined at 50 % relative humidity and shall be tested in accordance with ISO 6077. Films shall be tested preferably in low-density areas.

7.4 Thermal sticking

Processed film shall show no evidence of blocking (sticking), delamination or surface damage at high temperature when tested before and after accelerated ageing as specified in 9.2. Thermal sticking shall be tested as specified in 9.8. A slight sticking of film to glass which does not result in physical damage shall be acceptable.

8 Requirements for image stability

8.1 Proper development

Processed film shall not show a projection density decrease greater than 20 % when tested as specified in 10.2.

8.2 Residual diazonium salt test

Processed film shall not show a density decrease greater than 0,1 when tested as specified in 10.3.

8.3 Image stability: Light-fading

Low-density and high-density patches (see table 2) of the processed film shall be tested in a light-exposure apparatus as specified in 10.4. After testing, patches with low printing and low projection densities shall have a density of 0,7 or less. The difference between densities for patches with high and low printing densities shall be 0,8 or greater and that between patches with high and low projection densities shall be 1,4 or greater (see table 2). These density requirements shall apply to both projection and printing densities for Class A films and to projection densities only for Class B films (see annex E). The same density requirements shall apply for both LE-10 and LE-100 films.

Table 2 — Limits for change in image density after light-fading test

Vesicular density levels	Printing density	Projection density
Original		
Low density	< 0,4	< 0,4
High density — low density	> 0,8	> 1,4
Final		
Low density	⩽ 0,7	⩽ 0,7
High density — low density	⩾ 0,8	⩾ 1,4

8.4 Image stability: Dark-ageing of minimum-density area

Minimum-density patches of the processed film shall be incubated as specified in 10.5 using the two conditions specified for either LE-10 or LE-100 films. After incubation under each of the two conditions, the density patches with low printing and low projection densities shall have a density of 0,6 or less. These density requirements shall apply to both projection and printing densities for Class A films, and to projection density only for Class B films.

8.5 Image stability: Dark-ageing of vesicular image

A density patch having a projection density of 2,0 shall be incubated as specified in 10.6. After incubation, the projection density shall not show a density change greater than ± 0,03. This density requirement shall apply for both LE-10 and LE-100 films.

9 Test methods

9.1 Identification of film base

Remove all emulsion and backing layers from a sample of the unknown film by scraping. Then remove all sublayers by scraping. Prepare a sample of the base material by scuffing the surface with a suitable tool such as a razor blade. The general procedure is to move the scuffing device back and forth over the sample manually while exerting a very slight pressure. This removes the top layer of the base as a very fine dust. Carefully brush this into a mortar.

Mix the sample with about 100 times its mass of potassium bromide, previously ground to about 75 µm. Prepare a strip or pellet as described in reference [3].

Obtain an infrared absorption curve from the prepared strip or pellet by means of an infrared absorption spectrometer. By comparing the infrared absorption curve for the unknown with curves for known polymers, the identity of the unknown can be established (see reference [4]).

9.2 Accelerated ageing conditions

Processed film shall be subjected to accelerated ageing conditions to meet the requirements for increase in the amount of free acid, loss in tensile properties, binder stability and thermal sticking.

The test specimens shall be conditioned at (23 ± 1) °C and (50 ± 2) % relative humidity for at least 15 h. After conditioning, place the specimens in a moisture-proof envelope and heat-seal the envelope [2]. To prevent sticking between adjacent specimens, it may be necessary to interleave them with aluminium foil. Ensure a high ratio of film to air volume by squeezing out excess air prior to heat-sealing. Use a separate envelope for each film sample. Heat the envelopes in an oven for 72 h at (100 ± 2) °C [3].

An alternative method of incubating the specimens in a closed environment is by placing them in 25 mm borosilicate glass tubes (see reference [5]). Each tube shall have two flanged sections separated by a gasket to provide a moisture seal [4] and shall be held together by a metal clamp. Sufficient film specimens shall be used to provide a high ratio of film to air volume.

NOTE 5 In the subsequent text, samples subjected to these accelerated ageing conditions are designated "heated film". Comparison samples kept under room conditions are designated "unheated film".

9.3 Determination of the amount of free acid

9.3.1 Specimen preparation

Measurements shall be made on two unheated and two heated specimens of imaged film that weigh approximately 1 g to 2 g each. Weigh the specimens to the nearest 0,01 g. Heat the films in accordance with 9.2. Remove all coatings from the film base by scraping. Cut each specimen into small pieces and accurately weigh it prior to dissolving it in the appropriate solvents.

9.3.2 Solution preparation

Immerse the specimens in 30 ml of a 70/30 (*m*/*m*) mixture of purified *o*-cresol/chloroform (DANGER: ⟨B⟩ ⟨C⟩ ⟨S⟩).

2) A suitable moisture-proof envelope is a metal foil bag that is coated on the inside with polyethylene for heat-sealing.

3) Incubation is accomplished in a closed environment to prevent escape of any acid that may be produced during incubation. Such acid may catalyse further film base degradation.

4) A suitable inert gasket can be made from polytetrafluoroethylene.