

International Standard



5466

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Photography — Processed safety photographic film — Storage practices

Photographie — Films photographiques de sécurité traités — Directives pour l'archivage

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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.

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 5466 was prepared by Technical Committee ISO/TC 42, *Photography*.

This second edition cancels and replaces the first edition (ISO 5466-1980), of which it constitutes a technical revision.

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 — Processed safety photographic film — Storage practices

0 Introduction

Photographic film is an important documentary and pictorial material. There is a recognized need for information on safeguarding photographic films having legal, scientific, industrial, or historical value. The value of such records used in archives, museums, libraries, government, commerce and universities has focused attention on the care of such records to ensure their longest possible life ^{[1] [2],*}

Films are susceptible to degradation from many sources. These factors may be divided into three general categories :

a) Nature of the photographic film

The stability of photographic film records depends on the physical and chemical nature of the film. Only safety photographic films are suitable for storage, the specifications for safety photographic film being described in ISO 543 and ISO 7830. The optimum film material for preservation is silver-gelatin type film which meets the requirements of ISO 4331 or ISO 4332 for archival film.

This International Standard also applies to processed colour, diazo, and vesicular film. Although these film types are not currently covered by any ISO specification, excellent keeping experience has been obtained with many of them for as long as 30 years.

For optimum preservation of photographic information, archival-record film should be used and it should be stored under optimum storage conditions.

b) Photographic processing of the film

For silver-gelatin type archival film ISO 4331 and ISO 4332 specify a maximum residual thiosulfate level.

c) Storage conditions

The conditions under which safety photographic film records should be stored are extremely important for the preservation of the film.

The important elements affecting preservation of processed film are humidity and temperature of the air, as well as the hazards of water, light, fungal growth, insects, microbiological attack, contact with certain chemicals in solid, liquid or

gaseous form, and physical damage. The extent to which humidity, temperature, or variations of both, can be permitted to reach beyond recommended limits without producing adverse effects will depend upon the duration of exposure, on biological conditions conducive to fungal growth, and on the accessibility of this atmosphere to the film surfaces.

The recommendations of this International Standard also pertain to enclosure materials, containers, fire protection, and inspection. This International Standard is not designed to provide protection against natural or man-made catastrophes, with the exception of fire and associated hazards which are sufficiently common to warrant inclusion of protection steps.

Storage conditions for photographic records are of two classes : 1) medium-term and 2) optimum. The storage protection provided by each class will differ in degree because of the cost of providing storage facilities, desired record life, and frequency of record use. Storage conditions may be chosen within specified limits representing a satisfactory compromise between degree of protection required and practical considerations of immediate availability.

1 Scope and field of application

1.1 This International Standard gives recommendations concerning the storage conditions, storage facilities, handling, and inspection for all processed safety photographic films (hereafter referred to as photographic film) in roll, strip, aperture-card, or sheet form, regardless of size.

1.2 This International Standard applies only to safety photographic film (see ISO 7830 and ISO 543). Nitrate base films are hazardous and unstable and are not covered by this International Standard ^{[3] [4]}.

1.3 The storage of photographic paper and photographic plates requires different considerations and these are not covered in this International Standard.

1.4 This International Standard applies to optimum and medium term storage of photographic film as defined in clause 3.

* Numbers in brackets ^[1] refer to the references in the bibliography.

1.5 This International Standard applies to photographic film records intended as storage copies. These storage copies would not be in frequent use. This International Standard does not apply to work copies. If frequent use is required, duplicate work copies of the records shall be made.

1.6 This International Standard, while intended for materials that are well processed, should also be of considerable value in prolonging the useful life of photographic film whose processing conditions are unknown, or that have been toned, retouched or bear markings with materials of uncertain or unknown stability. It is not intended to predict or assign a useful lifetime to photographic film stored in accordance with the specifications of this International Standard.

2 References

ISO 543, *Cinematography — Motion-picture safety film — Definition, testing and marking*.

ISO 3897, *Photography — Silver image photographic plates for record purposes — Storage conditions*.

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 6051, *Photography — Silver image photographic paper prints for record purposes — Storage conditions*.

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 safety photographic film : Film meeting the specifications as defined in ISO 543 and ISO 7830.

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

3.3 long-term film : A photographic film which is suitable for the preservation of records for a minimum of 100 years under "optimum" storage conditions, providing the original images are of suitable quality.

3.4 archival film : A photographic film which is suitable for the preservation of records having permanent value under "optimum" storage conditions.

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

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

3.6 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.

3.7 fire-protective storage : Facilities designed to protect photographic film against excessive temperatures, water and other fire-fighting agents, steam developed by insulation of safes, and collapsing structures.

3.8 insulated record containers : Containers as defined in appropriate national standards and regulations¹⁾.

3.9 fire-resistive vaults : Vaults as defined in appropriate national standards and regulations²⁾.

3.10 open enclosure : Enclosure which is intended for the physical protection against mechanical damage but is neither light-tight nor air-tight.

Such enclosures may be reels, cores, spools, cassettes, magazines, folders, envelopes, cartons, sleeves, transparency mounts and aperture cards.

3.11 protective enclosure : Light-tight, impermeable container used for protection from outside factors such as reactive gases, and moisture, including relative humidity changes.

Such enclosures may be taped cans and sealed envelopes.

4 Composition of enclosure materials

4.1 General

The enclosure material shall be free from acidic, oxidizing and reducing agents which may be released slowly with time and cause image instability or chemical decomposition of the film. For example ageing blemishes in processed microfilm may be influenced by chemicals evolved from paper storage cartons ^{[7][8]}.

Likewise, the presence of acid in paper that is in contact with photographic materials can cause degradation.

The enclosure itself shall be chemically stable. Otherwise the decomposition products might be harmful to the photographic material, and dirt or dust might be produced that could scratch or become embedded in the image surface. Cellulose nitrate and glassine sheeting are examples of unsatisfactory enclosure materials because of their own instability ^{[9][10]}.

1) Example : Class 150 of UL 72-1977 ^[5].

2) Example : Publication NFPA No. 232-1975 ^[6].

The physical surface of the enclosure material contacting the film is also important. A very smooth glossy surface can result in sticking or ferrotyping of the image surface. A slightly rough or matt surface is recommended for the filing enclosure, but a very rough surface can produce abrasion problems.

The enclosure material and the photographic material to be stored shall meet the requirements of the photographic activity test as described in 11.1. This incubation test determines whether there is a chemical interaction between the particular components of the package. The adhesive used for seams and joints shall also meet this requirement.

For maximum storage life, photographic film shall be in a clean condition before being placed in storage.

4.2 Paper

The paper shall be made from rag, bleached sulfite, or bleached kraft pulp with an alpha-cellulose content greater than 87 % as determined by an appropriate method [11]. It shall be free from highly lignified fibres such as ground wood, as determined by the phloroglucinol spot test.

For paper in direct contact with black-and-white photographic material the pH shall be between 7,5 and 9,5, as determined by an appropriate method [12]. The pH shall be close to 7,0 when in direct contact with colour or diazo material. There shall be an alkali reserve of at least 2 % (m/m), as determined by the alkali reserve test described in 11.2 [13]. The alkali reserve shall be obtained by the incorporation of an alkaline earth carbonate.

A minimum of sizing chemicals shall be used, the amount being dictated by the requirements of the end use (enclosure, overwraps, interleaving, etc).

Neutral or alkaline sizing chemicals shall be employed. The material shall essentially be free from particles of metal. Surface fibres that might offset on to photographic layers should not be present. The paper shall not contain waxes, plasticizers, or other ingredients that may transfer to the photographic material during storage. Glassine envelopes [9] shall not be used. The paper shall meet the physical tests required for the particular application, these include stability [14], folding endurance [15], and tear resistance [16].

Where the high-humidity conditions favourable for fungus growth may occur, the user should provide controlled conditions of lower humidity. This will eliminate the need for a fungicide treatment. Where it is not possible to provide lower humidity storage, the paper used for the enclosure should be relatively non-porous and treated with a fungicide. The effectiveness of such a fungus-resistant treatment should be determined [19]. Additive treatments for fungus protection should be used with extreme caution. There may be long-term effects of the fungicide with respect to its efficiency and safety, as well as an interaction with the photographic material.

4.3 Plastic

Suitable plastic enclosure materials are photographic film support materials such as uncoated polyester (polyethylene terephthalate) and uncoated cellulose acetate. Uncoated polyethylene has been found suitable as it is generally inert,

unplasticized, and has good chemical stability. Other plastics may be satisfactory, but there has been no extended experience with such materials.

Chlorinated or nitrated sheeting shall not be used, and cellulose nitrate in particular shall be avoided. Polyurethane foam shall not be used [9].

Highly-plasticized sheetings or coatings shall not be employed as this might result in either sticking or ferrotyping of the image surface. Plastics of unknown quality containing residual solvents or plasticizers are suspect because such solvents may escape and have a harmful effect on the photographic image. The plastic materials shall be free of peroxides.

The plastic shall meet the physical tests required for the particular application. These include folding endurance [15], tear resistance [17], and tensile strength [18].

4.4 Metal

Metals shall be non-corrodible such as anodized aluminium or stainless steel. The use of steel is permissible provided the surface is well protected by lacquer, enamel, tinning, plating or some other corrosion-resistant finish. Lacquer which might give off reactive fumes, peroxides or exudations during storage shall not be used (see annex C). Cabinets painted with oil base paints shall not be used for 3 months as they may give off peroxides.

4.5 Adhesive

If an adhesive is used, it shall have no harmful effect on the photographic image or enclosure when tested by the photographic activity test outlined in 11.1. Some photographic images can be damaged by adhesives incorporating impurities such as sulfur, iron, copper, or other ingredients that might react with image silver or gelatin. Pressure-sensitive adhesives and ether-linked products shall be avoided. If a particular brand of commercially-made adhesive is found to be safe for long-term storage purposes, there is no assurance that subsequent batches will contain ingredients of the same purity. Rubber-base products such as rubber cement shall not be used. Not only might they contain harmful solvents or plasticizers, but they might be compounded with photographically-damaging sulfur, usually as a vulcanizer, accelerator, or stabilizer. Even some "low-desensitizing" or "sulfur-free" rubbers contain sulfur.

Photographic quality gelatin and many polyvinyl acetate and cellulose ester adhesives are suitable for use with paper enclosures. Heat sealing and mechanical sealing should be used when possible.

4.6 Printing inks

The printing ink shall have no harmful effect on the photographic image when tested by the photographic activity test outlined in 11.1. Printing inks have been known to cause microscopic spots in fine-grain silver microfilm [7]; consequently, there shall be no printed matter on the inside of the filing enclosure. The ink used for imprinting the outside of filing enclosures shall not bleed, spread, or transfer, nor shall it be a source of products that attack the photograph or the enclosure itself.

5 Film enclosures

5.1 Film in roll form

5.1.1 Medium-term storage enclosures

Aerial film, microfilm, motion-picture film and some portrait films are wound on reels or cores and stored in roll form. Rolls shall all be wound tightly but not under extreme tensions. Rolls, mounted on cores, shall be stored with the core axis vertical. If it is necessary to store rolls less than 20 cm in diameter with the core axis horizontal, the roll shall be supported so that the lower part of the film does not support the weight of the roll.

Rolls of photographic film should be stored, preferably, in closed enclosures to provide protection against dirt and physical damage unless the film is protected by the storage housing (see clause 6). Colour and diazo films shall be stored in closed, opaque enclosures or be otherwise protected from light exposure. Suitable enclosures are containers with telescoping, slip-type, or threaded twist-on lids. The materials used shall meet the same requirements as those for cores and reels. Closed enclosures are not necessarily airtight and may give limited access to ambient air. Therefore if they are used, the humidity of the ambient air shall not exceed the recommended limits.

Protective enclosures made from impermeable materials shall be used, where needed to maintain humidity limits of the film (see clause 8), to protect against gaseous impurities in the atmosphere or when low temperature storage is used. Cardboard enclosures are not recommended for microfilm because of the danger of microscopic blemishes (see annex E). Suitable enclosures are closed containers with friction-type or threaded, twist-on lids having an incorporated seal. Rubber gaskets shall not be used. Flip-top, hinged or telescoping lids can be used, but the joint shall be sealed by several wraps of pressure-sensitive adhesive tape having low gas permeability. Taped cans within heat-sealed foil bags provide additional protection from high humidity. If tape is used, routine retaping of joints every 2 years is recommended; in any case, if the tape seal is observably deficient in integrity, it shall be replaced.

Any film which is not essentially free from gas release¹⁾ shall be stored in separate storage housings (see clause 6). Polystyrene or polyethylene enclosures are preferable to cardboard or metal enclosures for such films.

5.1.2 Optimum storage enclosures

For optimum storage, the requirements of 5.1.1 shall be met. Rubber bands shall not be used for confining film on reels or cores. If paper bands are used, the paper shall meet as a minimum requirement the specifications described in 4.2. Films on reels may be confined by tucking the film end between the roll and flange.

Films may have possible interactions with other films which are of a different generic type (for example, diazo and silver-

gelatin). Films of different generic type shall not be wound in the same rolls or stored in the same enclosures.

Enclosures shall be non-corrodible, peroxide-free and not highly plasticized as described in 4.3 and 4.4.

Periodic inspection shall be made as outlined in 10.2.

5.2 Film in sheet and slide form

5.2.1 Medium-term storage enclosures

Film in sheet form may be stored in envelopes of paper or plastic foil, folding cartons, file folders, aperture cards or in film strip jackets. Photographic slides may be stored in cardboard, metal, or plastic boxes. Colour or diazo films shall be stored in opaque envelopes or folders or otherwise protected from light exposure. Films should not be stacked as this could cause excessive pressure on the lower ones.

When in direct contact with the surface of the photographic film, the paper or plastic material used for envelopes, sleeves, jackets, folders, and cartons shall meet as a minimum requirement the specifications described in 4.2 and 4.3. Adhesive used shall meet the requirements described in 4.5.

Protective enclosures shall be used where needed, to maintain humidity within the limits of the film (see clause 8), to protect against gaseous impurities in the atmosphere, or when low temperature storage is used. Heat-sealable envelopes consisting of aluminium foil extrusion coated with clear polyethylene on the inside and laminated to a suitable paper sheet on the outside have been successfully used as sealed enclosures. Precautions should be taken in handling these envelopes so that they are not punctured.

The filing enclosure shall be constructed so that any seam or joint will be at the edge of the enclosure and not in contact with the film surface.

Any film which is not essentially free from acid release¹⁾ shall be stored in plastic envelopes and in separate storage housings (see clause 6).

For maximum storage life, photographic film shall be in a clean condition before being placed in storage

5.2.2 Optimum storage enclosures

For optimum storage the requirements of 5.2.1 shall be met.

Films may have possible interactions with other films which are of a different generic type (for example, diazo and silver-gelatin). Films of different generic types shall not be interfiled or be in physical contact.

Periodic inspection should be made as outlined in 10.2.

1) Some vesicular films give off acidic fumes which may interact with silver, diazo, or dye-gelatin type films.

6 Storage housing

Photographic film should be stored in closed housings such as drawers, or on shelves and racks enclosed by doors to provide protection from dust and dirt. Alternatively, open shelves and racks may be used if the film is in closed containers. The storage housing materials shall be non-corrodible as described in 4.4. They shall also be non-combustible. Because of their combustible nature and the possibility of producing active fading agents on ageing, materials made of wood, wood pressed-board, hard-board, particle-board and other natural material shall be avoided.

The finish on housing materials should be durable and not contribute deleterious effects to the stored photographic film. Adverse effects may be produced by finishes containing chlorinated or highly-plasticized resins, or by freshly-painted or lacquered surfaces.

When air-conditioned individually, storage housings shall be arranged to permit interior circulation of air to all shelves and drawers holding film containers to allow uniform humidity conditions. Storage housings located in rooms conditioned in accordance with 8.1 shall be provided with ventilation openings permitting access of air to the interior. Such openings shall not interfere with requirements for fire-protective storage or water protection.

Films which are not essentially free from release of acidic fumes shall not be stored in the same storage housing as other photographic products.

7 Storage rooms

7.1 Medium-term storage rooms

Rooms and areas used for film storage should be associated with rooms allowing facilities for inspection and viewing of the film. Good housekeeping is essential. Walls and enclosures of air-conditioned spaces shall be designed to prevent condensation of moisture on interior surfaces and within walls, especially during periods of low exterior temperatures when the walls may be cooled below the dew point of the air. Provisions shall be made against damage of film by water from floods, leaks, sprinklers, etc. Storage rooms or vaults should be located above basement levels where possible. A special storage room separate from the work areas for film records of medium-term interest will generally not be required, provided that conditions as recommended in 8.1.1 are maintained. Films which are not essentially free from release of acidic fumes, such as some vesicular films, shall be stored in separate storage rooms.

7.2 Optimum storage rooms

The value of photographic film kept for long-term or archival purposes makes it advisable to provide a storage room or vault separate from temporary storage facilities, offices, or work areas. Storage rooms for films which are not essentially free from acid release shall have a separate circulating air system (see also annex E).

Storage rooms have been constructed in caves and mines and have proven very satisfactory when accepted requirements for the environmental conditions (see 8.1) and air purity (see 8.3) are met.

8 Environmental conditions

8.1 Humidity and temperature limits (see annexes A and B)

8.1.1 Medium-term storage environment

The relative humidity shall not exceed 60 % and for silver-gelatin film on polyester base it shall not be lower than 30 %. Ideally, a maximum temperature for extended periods shall not exceed 25 °C, and a temperature below 20 °C is preferable. Peak temperature for short time periods shall not exceed 32 °C. For colour film, a storage temperature not exceeding 10 °C is recommended for proper protection. Cycling of humidity or temperature should be avoided. Protection may be increased by storing at low temperature and low relative humidity.

8.1.2 Optimum storage environment

The relative humidity range for optimum storage varies with the product type according to the table.

When several film types are to be stored within the same storage area, the recommended relative humidity is 30 %. Short-term cycling of humidity should be avoided.

Table — Recommended relative humidity range

Sensitive layer	Base type	Recommended relative humidity range %
Microfilm		
Silver-gelatin	Cellulose ester	15 to 40
Silver-gelatin	Poly(ethylene terephthalate)	30 to 40
General		
Silver-gelatin	Cellulose ester	15 to 50
Silver-gelatin	Poly(ethylene terephthalate)	30 to 50
Colour	Cellulose ester	15 to 30
Colour	Poly(ethylene terephthalate)	25 to 30
Diazo	Cellulose ester	15 to 30
	Poly(ethylene terephthalate)	
Vesicular	Poly(ethylene terephthalate)	15 to 50

When inactivity of an archival film permits, protection may be increased by conditioning and sealing the film (see 5.1.1 and 5.2.1) in equilibrium with air at the lower end of the recommended relative humidity range. This may be accomplished by running roll film, as a single strand, through a suitable conditioning cabinet, or hanging film sheets in such a cabinet. A conditioning time of 20 min is suitable. Individual rolls of film may be conditioned to the recommended storage humidity by keeping them in the recommended atmosphere 3 days for 16 mm film and 1 week for 35 mm film. Small quantities of roll film may be dried by keeping for 2 or 3 weeks in a desiccator.

without forced-air circulation and with a suitable quantity of activated silica gel. They should then be transferred quickly to cans or bags and sealed. Very low humidity conditions may produce brittleness or curl in films having a gelatin emulsion, by extraction of moisture from the emulsion. In such cases, it is good practice to recondition the film to a higher humidity prior to use. After use, reconditioning to the recommended humidity is required before replacement in sealed containers.

Temperatures shall not exceed 20 °C and added protection may be obtained for all films by low-temperature storage. A storage temperature of 2 °C or below is strongly recommended for colour film [20][21]. Two methods may be used :

a) The film may be conditioned to the recommended relative humidity, placed in hermetically sealed containers, and then placed in below-freezing storage [22]. Taped cans within heat-sealed foil bags may provide good moisture protection for roll films, while sheet films may be placed within two heat-sealed bags. The use of such bags improves moisture protection but does not guarantee it. This procedure has the advantage of excellent keeping conditions and the use of reasonably-priced deep-freeze units. It is essential to limit as much as possible the volume of free air in the sealed film container.

b) An alternative procedure is the use of a storage room controlled at 2 °C and at the recommended relative humidity. This eliminates the requirement of sealed containers but does require an expensive installation.

The container should be allowed to warm up to room temperature prior to opening, to avoid moisture condensation on the film (see annex B). Cycling of temperature should be avoided.

The recommended humidity and temperature conditions may be maintained either within individual storage housings or within storage rooms containing such housings.

8.2 Air-conditioning requirements

Properly controlled air-conditioning may be necessary for maintaining humidity and temperature within the limits specified, particularly for optimum storage where the requirements are more stringent than for medium-term storage. Slightly positive air pressure should be maintained within the storage room or vault. Air-conditioning installations and automatic fire control dampers in ducts carrying air to or from the storage vault shall be constructed and maintained on the basis of the recommendations contained in appropriate national standards and regulations¹⁾. They shall also follow recommendations for fire-resistive file rooms contained in appropriate national standards and regulations²⁾.

Automatic control systems are recommended and they shall be checked frequently. Where air-conditioning is not practical,

high humidities may be lowered by electrical refrigeration-type dehumidifiers, controlled with a hygrostat. Inert desiccants, such as chemically pure silica gel, may be used, provided the dehumidifier is equipped with filters capable of removing dust particles down to 0,3 µm in size and is controlled to maintain the relative humidity prescribed in 8.1. Dehumidification may be required in storage areas such as basements and caves that have inherently low temperatures and frequently exceed the upper humidity limit.

Humidification is necessary if the prevailing relative humidity is less than that recommended in 8.1 or if physical troubles such as curl or brittleness are encountered with active files. If humidification is required, a controlled humidifier shall be used. Water trays or saturated chemical solutions shall not be used because of the serious danger of over-humidification.

8.3 Air purity (see annex C)

Solid particles, which may abrade film or react with the image, shall be removed by mechanical filters from air supplied to housings or rooms used for storage. These mechanical filters are preferably of dry-media type having an arrestance rating of not less than 85 % as determined by tests contained in appropriate national standards and regulations³⁾. Filters shall be of non-combustible type, meeting the construction requirements of appropriate national standards and regulations⁴⁾.

Gaseous impurities such as sulfur dioxide, hydrogen sulfide, peroxides, ozone, acidic fumes, ammonia and nitrogen oxides can cause deterioration of the film base or degradation of the image in some films. They can be removed from the air by suitable washers or absorbers. An optimum storage film vault should be located as far as possible from an urban or industrial area where contaminants may be present in harmful concentrations. Where practical, storage of film in sealed containers in accordance with clause 5 will afford adequate protection.

As paint fumes may be a source of oxidizing contaminants, film shall be removed from either an optimum or medium-term storage area for a 3 month period when the area is freshly painted.

Gases given off by decomposing nitrate-base film will damage or destroy the image on safety film records stored in the same area [10]. Therefore, film shall not be stored with nitrate-base films, either in the same room or in rooms connected by ventilating ducts.

8.4 Light

Normally film is kept under dark conditions. This is recommended practice as light can be detrimental to some images.

1) Example : Publication NFPA No. 90A-1967 [23].

2) Example : Publication NFPA No. 232-1975 [6].

3) Example : Stain test of ASHRAE Standard 52-68 [24].

4) Example : Class 1 construction of UL 900-1971 [25].

9 Fire-protective storage (see annex D)

During heating for 4 h at 150 °C in the package that is to be stored, enclosure materials for fire-resistant storage shall not ignite or release more reactive fumes than the film itself does. Many enclosure materials will melt or become badly distorted at this temperature. However, this melting or distortion shall not cause damage to the film or prevent it from being removed from the enclosure. The materials used in reels or cores shall be neither more flammable nor more decomposable than the film which is stored on them.

For protection against fire and associated hazards, the film shall be placed in closed containers in either fire-resistive vaults or insulated record containers. If fire-resistive vaults are used, they shall be constructed in accordance with recommendations contained in appropriate standards and regulations¹⁾.

When the quantity of film is not too great, insulated record containers conforming to appropriate national standards and regulations²⁾ may be used. They will not exceed an interior temperature of 65 °C and an interior relative humidity of 85 % when given a fire exposure test from 1 to 4 h depending on the classification of the record container. Insulated record containers shall be situated on a ground-supported floor if the building is not fire-resistant.

For the best fire protection, duplicate copies should be placed in another storage area.

10 Film handling and inspection

10.1 Handling

Proper handling of film is important. Some types of film may be used frequently, generating damage and imposing critical handling and filing requirements. Good housekeeping and cleanliness are essential. Films should be handled by their edges and wearing of thin cotton gloves by the handlers is good practice.

10.2 Inspection

A number of different representative samples of film should be inspected at two-year intervals. If deviations from recommended temperature and relative humidity ranges have occurred, inspection should be made at more frequent intervals. A sampling plan established in advance should be used and a different lot should be inspected each time. Deterioration of either film or enclosure materials shall be noted.

There may be physical changes in the film (curl, distortion, brittleness, adhesion failure, etc.), visual changes in the film (fading, microblemishes, colour change) or changes in the enclosure material (embrittlement, discolouration). The cause of the problem should be determined and corrective action taken.

If film has been stored at a temperature below the dew point of the atmosphere where inspection is to take place, the film in its enclosure shall first be allowed to warm-up, before opening, to a temperature within a few degrees of that of the inspection room. The time required for heating increases with the volume of the film and the temperature difference (see annex B).

11 Test methods

11.1 Photographic activity test

The enclosure material and a representative sample of the processed photographic material to be stored shall be placed in close contact. Two such sandwiches shall be subjected to an accelerated ageing test of 50 ± 2 °C and 86 % relative humidity for 30 days. No other materials shall be in the same environment as the test materials during this period. At the end of this test, no visual pattern shall be transferred from the enclosure material to the photographic material, nor shall the image of the latter be affected. Any image change may be readily determined by having one-half of the photographic image against a piece of filter paper, having a pH between 7,0 and 7,7, during the incubation to serve as a control. Alternatively, paper conforming to the requirements of 4.2 may also be used. Some types of photographic film may undergo a colour or density change due to the incubation conditions. The changes produced by contact with the enclosure material shall be no greater than that produced by the film in contact with a filter paper control.

These temperature and humidity conditions can be readily obtained by storing the materials in a glass laboratory desiccator jar that can be placed in a forced-air circulating oven at 50 °C. The 86 % relative humidity can be obtained by keeping a saturated solution of potassium nitrate in water [26] at the bottom of the jar³⁾. Care shall be exercised in order that the saturated solution contains an excess of undissolved crystals at 50 °C. The undissolved crystals shall be completely covered by a layer of saturated salt solution, and the surface area of the solution should be as large as practicable. The jar and salt solution shall be at 50 °C for at least 20 h prior to use to ensure adequate equilibrium. Good circulation of air in the desiccator shall be accomplished, this being acquired by use of a built-in fan.

Alternatively, exposure to these temperature and humidity conditions may be provided by means of a conditioning air cabinet.

11.2 Alkali reserve test for paper

The paper enclosure material shall be conditioned to 23 °C and 50 ± 2 % relative humidity. A specimen of approximately 2,5 g shall be weighed to the nearest 0,01 g. It shall then be dispersed in 275 ml of water to form a slurry. The pH shall be measured as described in [12] of the bibliography. A sufficient volume of 0,1 mol/l acid shall be pipetted into the slurry to lower the pH to 3,0. A blank with 275 ml of water shall be prepared, and the

1) Example : Publication NFPA No. 232-1975 [6].

2) Class 150 of UL 72-1977 [5].

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

same volume of 0,1 mol/l acid as was used with the sample shall be pipetted into the blank. The sample and the blank solutions shall be boiled gently for about 1 min to expel carbon dioxide. After the sample and the blank solutions have cooled to room temperature, they shall each be back titrated with a 0,1 mol/l standard volumetric sodium hydroxide solution to a pH of 7,0.

The alkali reserve of paper, expressed as a percentage by mass, is given by the formula

$$\frac{0,050 \, 5c (V_0 - V_1) \times 100}{m}$$

where

c is the concentration, in moles per litre, of the sodium hydroxide solution used;

V_0 is the volume, in millilitres, of the sodium hydroxide solution required for blank titration;

V_1 is the volume, in millilitres, of the sodium hydroxide solution required for sample titration;

m is the mass, in grams, of the paper test specimen.

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Annex A

Humidity during storage

(This annex does not form part of the standard.)

Humidity appreciably beyond the limits specified in this International Standard can have a very deleterious effect on photographic film. Both the extremes of low and high humidity shall be avoided.

Prolonged exposure to conditions above 60 % relative humidity will tend to damage or destroy the gelatin emulsion layer due to growth of fungus, and will eventually cause sticking of the emulsion. High humidity exposure will also accelerate any effects of residual processing chemicals (for example, thiosulphate) on the stability of silver images and will impair the stability of dye images. Relative humidities above 90 % can lead to degradation of the film base.

Storage at low humidities not only avoids fungal growth but reduces the rate of chemical degradation. However, under conditions of low or cycling humidities, gelatin photographic layers and backing layers on polyester base sometimes develop adhesion defects such as edge peeling, flaking, or emulsion cracking. Consistent exposure to humidity below 15 % relative humidity will also tend to produce a temporary brittleness in gelatin emulsion films but flexibility can be restored by conditioning the film to 30 % relative humidity or higher. Film having a low moisture content is apt to develop static charges causing attraction of dust particles, but this difficulty may be avoided by appropriate discharging during handling and printing.

Annex B

Temperature during storage

(This annex does not form part of the standard.)

Continuous temperatures above 40 °C may permanently reduce the pliability of some film bases and may accelerate fading of dye images and vesicular images. While gelatin films become brittle at low temperatures (below 0 °C), flexibility is restored upon return to room temperature. Storage temperatures below the dew point of the air may produce condensation of moisture upon film surfaces unless container and contents are brought above the dew point temperature before removal of film. The required warm-up time might amount to several hours, depending on the size of the film package and the temperature differential.

An important aspect of temperature is its effect on relative humidity of the storage area. A fall in temperature may raise the relative humidity if the storage area is not humidity controlled. This may cause conditions beyond the range of recommended humidities for proper storage, and sealed containers must be used.

Annex C

Air-entrained and gaseous impurities

(This annex does not form part of the standard.)

When dust and other air-entrained solid particles are deposited on photographic film, they may interfere with legibility and produce scratches. Reactive types of dust may cause fading or staining of the image layer. Gaseous impurities such as sulfur compounds, peroxides, paint fumes and other active compounds may cause deterioration of the base and a chemical degradation of the photographic image. The most-frequently encountered impurity, especially in urban and industrial atmospheres, is sulfur dioxide, and small concentrations are likely to produce detrimental effects. Hydrogen sulfide is not a common impurity but is a very active one even at low concentrations; it can occur in air washers containing decomposed biological slime. Oxidizing gases, such as peroxides, are believed to be responsible for the local oxidation of image silver in fine grain images ^{[7][8][27]}, causing formation of minute deposits of coloured colloidal silver.

Suitable means for removal of gaseous impurities are available, such as air washers operating with treated water for elimination of sulfur dioxide, and activated carbon for the absorption of sulfur dioxide and hydrogen sulfide ^[28]. These require consistent control and, in the case of activated carbon, expert processing.

Annex D

Fire-protection

(This annex does not form part of the standard.)

Damage to photographic film records by high temperature can occur even if the film is not destroyed by fire. Photographic films show some physical distortion at 150 °C but the silver-gelatin image can withstand this temperature for several hours without significant loss in image quality. However, dye and diazo images may show some fading or change in colour balance. Vesicular images are generally destroyed at this severe condition. In addition to image loss, photographic films may become severely distorted at high temperatures so that they can only be viewed, projected, or printed with difficulty.

One danger to films, as a result of high temperature exposure, is that of sticking or blocking of adjacent sheets or laps, particularly with films having gelatin or special backings.

Steam generation and the resultant cooling effect is a design characteristic for the insulation of certain types of fire-resistant safes. Film shall be protected against steam; otherwise sticking, gelatin emulsion melting, and severe distortion will result. For this reason, insulated record containers designed to seal the contents against steam are recommended (see clause 9).

For very critical records and for greater fire protection, it is recommended that duplicate copies be stored in another location.