INTERNATIONAL STANDARD

ISO 18920

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Imaging materials — Processed photographic reflection prints — Storage practices

Matériaux pour image — Tirages photographiques traités par réflexion — Directives pour l'archivage

Reference number
ISO 18920:2000(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

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

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

International Standard ISO 18920 was prepared by Technical Committee ISO/TC 42, *Photography*.

This first edition cancels and replaces the fourth edition of ISO 6051 (ISO 6051:1997), and is mainly an editorial revision.

This International Standard is one of a series of standards dealing with the physical properties and stability of imaging materials. To facilitate identification of these International Standards, they are assigned a number within the block from 18900 to 18999 (see annex A).

Annexes A to I of this International Standard are for information only.

Introduction

Photographic and other reflection prints, including hard-copy output from digital imaging systems, have become increasingly important as documentary and pictorial reference material in archives, libraries, government, commerce and academia. This has focused attention on the importance of the preservation of such materials to ensure their longest possible life.

The stability and useful life of photographic reflection prints depend on their physical and chemical properties and the processing, as well as on the conditions under which they are stored and used. This International Standard provides recommendations on proper storage conditions and practices.

The important elements affecting the useful life of photographic reflection prints during storage are as follows:

— relative humidity and temperature of the storage environment;

— hazards of fire, water, and light exposure;

— fungal growth and other micro-organisms;

— contact with certain chemicals in solid, liquid, or gaseous form;

— physical damage.

The extent to which the relative humidity and temperature of the storage environment, or variations of both, can be permitted to reach beyond recommended limits without producing adverse effects will depend upon the duration of exposure, biological conditions conducive to fungal growth, and the accessibility of the atmosphere to the print surfaces.

The term "archival" is no longer used to express longevity or stability in International Standards on imaging materials since it has been interpreted to have many meanings, ranging from preserving documents "forever", which is unattainable, to temporary storage of actively used materials.

This International Standard defines two levels of recommended storage conditions: medium-term and extended-term. Medium-term storage conditions can be used to preserve information for a minimum of 10 years. Extended-term storage conditions shall be used when it is desired to preserve information for as long as possible, and these conditions will prolong the life of all prints, even those not optimized for permanence.

The space requirements and costs for establishing and operating the two levels of storage conditions (medium-term and extended-term) differ significantly. Furthermore, the specified limits of temperature and relative humidity for both sets of storage conditions may not be realizable due to budgetary constraints, energy considerations, climatic conditions, building construction, etc. However, it must be recognized that any deviation from the specified conditions will reduce the effectiveness of the storage environment. If such deviation is unavoidable, the lowest possible storage temperature should be provided. In any event, the best preservation of prints will be attained with extended-term storage conditions.

The recommendations of this International Standard for the storage of photographic reflection prints encompass the following:

— storage enclosures, housing, and rooms;

— atmospheric and environmental conditions;

— fire protection;

— handling and inspection procedures.

With the exception of fire and associated hazards that are sufficiently common to warrant inclusion of protective measures, this International Standard does not pertain to means or methods for protecting photographic reflection prints against natural or man-made catastrophes.

INTERNATIONAL STANDARD ISO 18920:2000(E)

Imaging materials — Processed photographic reflection prints — Storage practices

1 Scope

1.1 This International Standard specifies dark storage conditions, storage facilities, and procedures for the handling and inspection of photographic reflection prints of all types and sizes.

1.2 This International Standard is applicable to photographic reflection prints on the following opaque supports:

— fibre-base paper;

— RC (resin coated) paper;

— plastic films (polyester, cellulose acetate, etc.).

1.2.1 This International Standard is applicable to the following black-and-white silver gelatin prints:

— wet-processed, including those that have been chemically treated to improve the permanence of the silver image and/or to modify its colour (e.g. with gold, selenium or sulfur formulations);

— diffusion transfer (e.g. Polaroid and Fuji Photo Film instant prints[1)]);

— stabilization-processed (which contain the silver image as well as invisible, chemically stabilized silver halides);

— heat-processed.

1.2.2 This International Standard is applicable to the following multicolour and monochrome photographic prints:

— chromogenic, washed and stabilized;

— silver dye bleach;

— dye transfer;

— diffusion transfer (e.g. Polaroid and Fuji Photo Film instant prints[1)], peel-apart or integral);

— pigmented gelatin (carbon, carbro, etc.).

1.2.3 This International Standard is applicable to black-and-white and colour photographic reflection prints made with the following systems:

— thermal dye transfer (commonly referred to as dye sublimation);

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1) Polaroid and Fuji Photo Film instant prints are examples of suitable products available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of these products.

— thermal wax transfer;

— electrophotographic;

— ink jet;

— diazo.

1.3 Recommendations for storage of photographic films are given in ISO 18911 and for storage of processed photographic plates in ISO 18918. Print material on translucent film supports intended to be viewed primarily by transmitted light should be stored in accordance with ISO 18911.

1.4 This International Standard is applicable to medium-term and extended-term storage conditions as defined in clause 3.

2 Normative references

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

ISO 14523:1999, *Photography — Processed photographic materials — Photographic activity test for enclosure materials.*

ISO 18902:—[2)], *Imaging materials — Processed films, plates and papers — Filing enclosures and storage containers.*

ISO 18911:— [2)], *Imaging materials — Processed safety photographic films — Storage practices.*

ISO 18918:2000, *Imaging materials — Processed photographic plates — Storage practices.*

3 Terms and definitions

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

3.1
archival medium
recording material that can be expected to retain information forever, so that such information can be retrieved without significant loss when properly stored

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

3.2
extended-term storage conditions
storage conditions suitable for the preservation of recorded information having a permanent value

2) To be published.

3.3
fire-protective storage
facility designed to protect records against excessive temperatures, water and other fire-fighting agents, and steam developed by insulation of safes or caused by the extinguishing of fires and collapsing structures

3.4
fire-resistant vaults
fire-resistant vaults as defined in appropriate national standards and regulations [1, 2][3)]

3.5
insulated record containers (Class 150)
insulated record containers (Class 150) as defined in appropriate national standards and regulations [3, 4]

3.6
life expectancy
LE
length of time that information is predicted to be acceptable in a system at 21 °C and 50 % RH

3.7
medium-term storage conditions
storage conditions suitable for the preservation of recorded information for a minimum of 10 years

3.8
storage container
box or can used to store prints

3.9
storage enclosure
any item in close or direct contact with recording material such as folders, envelopes, sleeves, albums and mats

3.10
storage housing
physical structure supporting materials and their enclosures

NOTE It may consist of drawers, racks, shelves or cabinets.

4 Enclosures and containers

All enclosures and containers used for medium-term and extended-term storage shall meet the requirements of ISO 18902 and ISO 14523. This includes enclosures and containers that are in either direct or indirect contact with the prints. Photographic reflection prints may be stored in envelopes or sleeves of paper or plastic, file folders, folding cartons, boxes, and albums, or may be matted. Photographic reflection prints should be protected from unnecessary light exposure, especially colour and diazo prints which shall not be exposed at all.

Generally, prints smaller than 28 cm × 36 cm in size may be stored vertically, but shall be placed between rigid supports to minimize slumping and curling. Prints 28 cm × 36 cm or larger should be stored horizontally, unless mounted on rigid supports. Stacks of horizontal prints should be less than 5 cm high to prevent excessive pressure on prints at the bottom.

Multiple prints, stored within an enclosure or container, shall be oriented with the emulsion sides against back sides, never emulsion against emulsion.

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3) The numbers in square brackets refer to references listed in the bibliography.

Suitable plastic enclosure materials are uncoated polyester (polyethylene terephthalate), polystyrene, high-density polyethylene and polypropylene. Other plastics may be satisfactory, but there has been no extended experience with such materials. Glassine envelopes and chlorinated, nitrated, or highly plasticized sheeting shall be avoided. Specifically, cellulose nitrate and polyvinyl chloride are not acceptable.

Sealed enclosures shall be used where needed to maintain the desired moisture content of the prints, to protect against gaseous and solid atmospheric contaminants, or when low-temperature storage is used without humidity control. Heat-sealed foil bags can provide this protection.

The adhesive used for seams and joints shall also meet the requirements of ISO 18902 and ISO 14523. The filing enclosure shall be constructed so that the seam or joint will be at the edge of the enclosure and not in contact with the image layer. Photographic-quality gelatin, modified and photographically inert starch, some acrylic and polyvinyl acetate adhesives, and methyl cellulose are suitable adhesives for use with paper.

For maximum life, prints shall be in a clean condition before being placed in storage and shall be inspected periodically thereafter, as outlined in 9.3.

5 Storage housings

Photographic reflection prints should be stored in closable storage housings such as drawers or cabinets, in storage cabinets with tightly fitting doors, or on open shelves when enclosed inside containers. The storage-housing materials shall be non-combustible, non-corrosive, and chemically inert, for example, anodized aluminum, stainless steel, or steel with a non-plasticized synthetic resin-powder coating. Wood, pressboard, particle-board, plywood, and other such materials shall be avoided because of their combustible nature and the possibility of their producing active deteriorating agents as they age.

The finish on the storage housing materials shall be durable and shall not contain substances that can have a deleterious effect on the stored prints. Adverse effects may be produced by finishes containing chlorinated or highly plasticized resins, or by solvents off-gassing from freshly applied finishes. Paints used on cabinets may give off peroxides, solvents and other contaminants for up to three months after application. Cabinets made of stainless steel or anodized aluminum are recommended. Metal housing materials that have been powder-coated (a layer of resin particles that are electrostatically applied to the surface of the metal and then fused to the surface using heat without the use of chemical solvents) are also recommended.

When air-conditioned individually, storage housings shall be arranged to permit interior circulation of air to all shelves and drawers holding print containers, so as to provide uniform humidity conditions. Storage housing located in rooms conditioned in accordance with 7.2 shall be provided with ventilation openings that permit access of air to the interior. Such openings shall not interfere with the requirements for fire-protective storage or water protection.

Different types of prints and films may be stored in the same storage area. However, different types of material shall not be stored in the same enclosure or storage container. Magnetic tapes or optical disks shall not be stored in the same storage vault as photographic prints due to the possible deleterious effects.

6 Storage rooms

6.1 Medium-term storage rooms

Rooms and areas used for print storage should be located in the same area as rooms containing provisions for inspection and viewing of prints. Good housekeeping is essential. Walls and enclosed 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 prints by water from floods, leaks and sprinklers, and from the steam released from masonry walls during a fire. A special storage room separated from the work areas for print records of medium-term interest generally will not be required, provided the conditions recommended in 7.2 are maintained.

6.2 Extended-term storage rooms

For extended-term storage, the requirements of 6.1 shall be met. The value of photographic prints kept for long-term purposes makes it advisable to provide a storage room or vault separate from medium-term storage facilities, temporary storage facilities, offices or work areas.

7 Environmental conditions

7.1 Introduction

The recommended relative humidity and temperature conditions given in Table 1 shall be maintained either within individual storage housings or within storage rooms containing such housings.

7.2 Temperature and humidity specifications for storage (see annexes B, C and D)

7.2.1 Medium-term storage environment

The maximum temperature for medium-term storage shall be 25 °C. Cycling of temperature shall not be greater than ± 5 °C over a 24 h period, and the peak temperature shall not exceed 30 °C. Some temperature fluctuation is allowable as long as the relative humidity stays within the specified limits.

The relative humidity of a medium-term storage environment shall be between 20 % and 50 %, and cycling of relative humidity shall not be greater than ± 10 % over a 24 h period. The moisture content in prints shall not be greater than the moisture in equilibrium with these relative humidities. Storing prints at the lower limit of the specified relative humidity range may cause curling of the prints or physical damage during handling (see annex E); prints may need to be equilibrated to a higher relative humidity prior to use.

7.2.2 Extended-term storage environment

The maximum temperature for extended-term storage shall be as specified in Table 1. Cycling of temperature shall not be greater than ± 2 °C over a 24 h period, and some temperature fluctuation is allowable as long as the relative humidity stays within the specified limits.

The relative humidity of an extended-term storage environment shall be as specified in Table 1. The variation of relative humidity shall not be greater than ± 5 % over a 24 h period. The moisture content in prints shall not be greater than the moisture in equilibrium with these relative humidities.

For black-and-white silver, silver dye bleach, dye/silver diffusion transfer (instant), dye imbibition (transfer), pigment and diazo, a maximum storage temperature of 18 °C shall be used. Added protection may be obtained for all prints by low-temperature storage, as such storage improves the stability of both the print support and the image.

For multicolour and monochrome chromogenic dye prints and all other types of prints not specified, a maximum storage temperature of 2 °C shall be used. Excellent keeping behaviour has been obtained by storing colour prints at such low temperatures. The recommended humidity and temperature conditions may be maintained either within individual storage housings or within storage rooms containing such housings. Either of the following two methods may be used in order to prolong the useful life of prints.

a) The first method is to use a storage room controlled at 2 °C and maintained within the recommended relative humidity range. This method alleviates the need for sealed storage containers, but requires expensive equipment and facilities to maintain the environmental conditions. One problem is the danger of moisture precipitation on print surfaces when they are brought into a warm room. This can be avoided by placing prints in sealed moisture-proof containers or in heavy-gauge self-sealing plastic bags prior to removal from the cold vault and allowing them to warm above the dew-point prior to opening.

b) The second method is useful when prints are removed only infrequently from storage. In this method, the prints are equilibrated with air near the low limit of the specified relative humidity, then sealed in air-tight containers and placed in cold storage. The required humidity-conditioning period for fibre-base prints is 1 day and for RC (resin coated) prints is 7 days. Special heat-sealable foil bags are commonly used and double-bagging (one heat sealed bag within another) can be employed to minimize the problem of air leakage through tiny holes in the bag material. One advantage of this method is that environmental humidity control is not needed and relatively low-cost freezers or refrigerators can be used. A disadvantage is the requirement for reconditioning and rebagging prints to return them to cold storage each time they are removed for examination.

Very low-humidity conditions may produce brittleness in prints having a gelatin emulsion. In such cases, it is good practice to restore flexibility prior to use by reconditioning the prints up to a relative humidity not exceeding 50 %. After use, reconditioning to the recommended humidity is required before returning the prints to sealed containers.

The benefit of low-temperature storage is reduced dramatically when prints are taken out frequently and/or for extended periods of time into higher temperature environments (see annexes D, E and F).

Table 1 — Maximum temperature and average relative humidity ranges for storage

Process	Medium-term storage		Extended-term storage [a]	
	Maximum temperature [b]	Relative humidity range [c]	Maximum temperature [d]	Relative humidity range [e]
	°C	%	°C	%
Black-and-white silver Silver dye bleach Dye/silver diffusion transfer (instant) Dye imbibition (transfer) Pigment Diazo	25	20 to 50	18	30 to 50
Chromogenic dye	25	20 to 50	2 [f]	30 to 40
All others [g]	25	20 to 50	− 3	30 to 50

[a] Formerly known as "archival storage", see the introduction. For storage of historic still-photographic prints, see annex E for information.

[b] Cycling of temperature shall not be greater than ± 5 °C over a 24 h period; the peak temperature shall not exceed 30 °C.

[c] Cycling of relative humidity (RH) shall not be greater than ± 10 % over a 24 h period.

[d] Cycling of temperature shall not be greater than ± 2 °C over a 24 h period; the peak temperature shall not exceed the specified maximum temperatures. No lower temperature limit is specified; however − 20 °C is a practical lower limit when considering the mitigating effect on life expectancy by time out of storage (see annex D).

[e] Cycling of relative humidity shall not be greater than ± 5 % over a 24 h period.

[f] Generally, stability of chromogenic prints is 10 to 15 times greater when stored at 2 °C compared to room temperature storage. The extended-term storage conditions specified for chromogenic prints differ from those specified for chromogenic colour film materials. The two temperature limits specified for prints are also specified for film; the corresponding relative humidity ranges specified for prints are higher due to potential physical problems such as curl and brittleness. The following environmental conditions meet the recommendations of this International Standard and ISO 18911 and are suitable for the storage of both types of materials: a maximum temperature of 2 °C and an RH of 30 % and a maximum temperature of − 3 °C (minus three degrees Celsius) and an RH range of 30 % to 40 %. Older and historic chromogenic colour print materials are comparatively less stable and may be stored at a colder temperature to increase the life expectancy of the prints (see annex E).

[g] The rates of degradation and the potential for physical problems due to low temperature and/or low relative humidity storage with print materials using newer technologies, such as thermal wax transfer, thermal dye transfer (commonly known as dye sublimation), electrophotographic colour, and ink jet, are currently unknown.

7.3 Environmental conditioning requirements

Properly controlled air-conditioning may be necessary for maintaining humidity and temperature within the specified limits, particularly for extended-term storage where the requirements are more stringent than those 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 storage vaults shall be constructed and maintained on the basis of recommendations contained in appropriate national standards and regulations [5, 6]. They shall also follow recommendations for fire-resistant file rooms contained in appropriate national standards and regulations [1, 2]. Masonry or concrete walls may release steam from internally bonded water when heated in a fire. A vapour barrier is required for such vaults, or else sealed containers shall be used.

Automatic control systems are recommended, and they shall be checked frequently with a reliable hygrometer that has been properly calibrated. Where air-conditioning is not practical, high humidities may be lowered by electrical refrigeration-type dehumidifiers and controlled with a humidistat set at the desired humidity level. Desiccants, such as chemically pure silica gel, may be used provided they are enclosed within units equipped with filters (see 7.4) capable of removing dust particles 0,3 µm in size and larger, and are controlled to maintain the relative humidity specified in 7.2. Dehumidification may be required in storage areas such as basements and caves. Because of their location, these areas 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 7.2, or if photographs in active files suffer physical damage, such as curling of the prints or delamination of the image layer from the support, due to increased brittleness or dryness at lower relative humidities. If humidification is required, a controlled humidifier should be used. Water trays or saturated chemical solutions shall not be used because of the serious danger of over-humidification.

7.4 Air purity (see annex G)

Solid particles, that may abrade prints or react with the image, shall be removed by mechanical filters from air supplied to housings or rooms used for extended-term storage. These mechanical filters should preferably be of the dry-media type having an arrestance rating of not less than 85 %, as determined by tests contained in appropriate national standards and regulations [7, 8]. Filters shall be of a non-combustible type, meeting the construction requirements of appropriate national standards and regulations [8, 9].

Gaseous impurities such as sulfur dioxide, hydrogen sulfide, peroxides, ozone, ammonia, acidic fumes, solvent vapours, and nitrogen oxides cause deterioration of the print support or degradation of the image in some prints. Suitable washers or absorbers can remove them from the air. Where practical, storage of prints in sealed enclosures, containers and storage housings in accordance with clauses 4 and 5 will afford adequate protection.

Since paint fumes may be a source of oxidizing contaminants, prints should be removed from either an extended-term or medium-term storage area for a 3 month period when the area is freshly painted.

8 Fire-protective storage (see annex H)

Enclosure materials for fire-resistant storage shall be sufficiently fire-resistant so that they will not ignite or develop reactive fumes after heating for 4 h at 150 °C in the package that is to be stored. Many enclosure materials will melt or become badly distorted at this temperature. Do not use enclosures that deform or melt to the extent that the photographic contents cannot be removed from the enclosure or are themselves permanently deformed.

For protection against fire and associated hazards, prints shall be placed in closed containers in either fire-resistant vaults or insulated record containers (Class 150) [3, 4]. If fire-resistant vaults are used, they shall be constructed in accordance with recommendations contained in appropriate national standards and regulations [1, 2], with particular care taken for protection from steam.

When the quantity of prints is not too great, insulated record containers (Class 150) conforming to appropriate national standards and regulations may be used. An interior temperature of 66 °C and an interior relative humidity of 85 % shall not be exceeded when carrying out a fire-exposure test lasting from 1 h 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 of the print records should be placed in another storage area.

9 Print identification, handling and inspection (see annexes E, F and I)

9.1 Identification

Processed prints are frequently inscribed with identification marks using non-photographic means such as ink, felt marking pens, or pressure-sensitive labels. Such identification materials shall pass the photographic activity test as described in ISO 14523.

9.2 Handling

Proper handling of prints is important. If prints are used frequently, this generates damage and necessitates the imposition of critical handling and filing requirements. Good housekeeping and cleanliness are essential. Prints shall be handled by their edges, and be properly supported during use to prevent flexing, creasing, or sagging. Handlers shall wear thin, clean, cotton or plastic gloves.

9.3 Inspection

An adequate number of properly selected lot samples of prints should be inspected at 2 year to 3 year intervals. If deviations from recommended temperature and relative-humidity ranges have occurred, inspection should be made at more frequent intervals. A random sampling plan established in advance of inspection shall be used.

If signs of deterioration of either prints or enclosure materials are noted, corrective action shall be taken, such as improving humidity and temperature controls or replacing poor quality storage enclosures and containers. If these actions are insufficient, high quality duplicates should be made on known stable material. A record of the inspection results should be maintained to monitor changes in the appearance of prints. Periodic reinspection shall be performed to ensure that corrective actions are effective.

Care shall be taken during the inspection to prevent abrasion, since prints can be physically scratched. Changes to note during the inspection include:

— physical changes in the print (warping and other planar distortions, emulsion cracking and adhesion failure);

— visual changes (fading, microblemishes, colour change);

— changes in the emulsion materials (embrittlement, discolouration).

If possible, the cause of the problem should be determined and eliminated.

Annex A
(informative)

Numbering system for related International Standards

The current numbering system for TC 42 documents dealing with the physical properties and stability of imaging materials is confusing since the five digit numbers that are used are not in any consecutive order. To facilitate remembering the numbers, ISO has set aside a block of numbers from 18900 to 18999 and all revisions and new International Standards will be given a number within this block. The last three digits will be identical to the current ANSI/PIMA numbers of published documents. This will be advantageous to the technical experts from Germany, Japan, United Kingdom and the USA who have prepared the standard and who are familiar with the ANSI/PIMA numbers.

As the current International Standards are revised and published, their new numbers will be as given in Table A.1.

Table A.1 — New ISO numbers

Current ISO number	Title	New ISO number
10602	Photography — Processed silver-gelatin type black-and-white film — Specifications for stability	18901
10214	Photography — Processed photographic materials — Filing enclosures for storage	18902
6221	Photography — Films and papers — Determination of dimensional change	18903
5769	Photography — Processed films — Method for determining lubrication	18904
8225	Photography — Ammonia-processed diazo photographic film — Specifications for stability	18905
543	Photography — Photographic films — Specifications for safety film	18906
6077	Photography — Photographic films and papers — Wedge test for brittleness	18907
8776	Photography — Photographic film — Determination of folding endurance	18908
10977	Photography — Processed photographic colour films and paper prints — Methods for measuring image stability	18909
4330	Photography — Determination of the curl of photographic film and paper	18910
5466	Photography — Processed safety photographic films — Storage practices	18911
9718	Photography — Processed vesicular photographic film — Specifications for stability	18912
12206	Photography — Methods for the evaluation of the effectiveness of chemical conversion of silver images against oxidation	18915
14523	Photography — Processed photographic materials — Photographic activity test for enclosure materials	18916
417	Photography — Determination of residual thiosulfate and other related chemicals in processed photographic materials — Methods using iodine-amylose, methylene blue and silver sulfide	18917
3897	Photography — Processed photographic plates — Storage practices	18918
14806	Photography — Thermally processed silver microfilm — Specifications for stability	18919
6051	Photography — Processed reflection prints — Storage practices	18920
15524	Photography — Polyester-base magnetic tape — Storage practices	18923
15640	Photography — Imaging materials — Test method for Arrhenius-type predictions	18924

Annex B
(informative)

Humidity during storage

Relative humidity appreciably beyond the limits specified in this International Standard can have a very deleterious effect on reflection prints. The extremes of both low and high humidity should be avoided.

Prolonged exposure to conditions above 60 % relative humidity will tend to damage or destroy the gelatin emulsion layers due to the growth of fungus, and will eventually cause the emulsion to stick to other surfaces such as storage enclosures. Exposure to high humidity will also accelerate any effects of excess residual silver halide and processing chemicals (e.g. thiosulfate) on the stability of silver images and will impair the stability of dye images. High relative humidities can accelerate degradation of the print base.

Storage at low humidity not only inhibits fungal growth, but also reduces the rate of chemical degradation. Recent investigations have shown markedly improved film base and emulsion stability when the storage humidity is reduced below 50 % relative humidity. However, low relative humidity exposure can result in high print curl, which may produce permanent print deformation. Also, low relative humidities can cause emulsion brittleness, which makes prints more susceptible to physical damage such as cracking and creasing during handling and can exacerbate existing physical problems such as cracking or delamination.

Annex C
(informative)

Temperature during storage

Continuous storage temperatures above approximately 40 °C may permanently embrittle and deteriorate emulsion layers of processed photographic prints, reduce the pliability of some print bases, and may accelerate the fading of dye images. Consistent exposure to dry heat promotes contraction or distortion of the photographic layer.

Although gelatin emulsion layers become more brittle at low temperatures (below 0 °C), flexibility is restored upon return to room temperature. Brittle prints are susceptible to physical damage, such as cracking, delamination, and creasing during handling; therefore, prints should be handled carefully at lower temperatures and flexing of the prints should be avoided.

Storage temperatures which are below the dew-point of the air in the area for use may cause moisture condensation upon print surfaces, unless the container and contents are brought above the dew-point temperature before removal of the prints. The required warm-up time might amount to several hours, depending on the size of the packaged prints and the temperature differential.

An important aspect of temperature is its effect on relative humidity. Low-storage temperatures 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; in such a case, sealed containers should be used.

Annex D
(informative)

Temperature/relative humidity relationship

Degradation of prints is caused by chemical reactions whose rates are lowered with decreasing temperature and humidity. Consequently, either lowering the storage temperature or storage humidity can increase the useful life of prints. Moreover, a lower storage temperature can compensate for a higher humidity to obtain the same life expectancy. This relationship permits several temperature/relative humidity combinations to be acceptable for extended-term storage conditions as specified in Table 1. This gives the storage vault designer a range of options.

The beneficial effect of cool/cold storage and/or storage at lower relative humidities can be mitigated by frequent or prolonged removal of prints from the storage vault. The effect of the time out of storage has been mathematically modelled [10] using data from accelerated ageing studies on the stability of colour dyes and photographic film bases. The illustrative chart in Table D.1 shows the effect of time out of storage.

Table D.1 — Time-out-of-storage relationship

Storage conditions		Days per year at room temperature [a]				
		0	5	10	30	60
Temperature °C	Relative humidity %	Relative longevity [b]				
20	50	1	1	1	1	1
	30	2	2	2	2	2
10	50	5	4	4	4	3
	30	9	8	7	5	4
0	50	18	14	12	7	5
	30	33	23	18	9	5
−10	50	71	36	24	11	6
	30	132	47	29	11	6
−20	50	288	58	32	12	6
	30	538	64	34	12	6

[a] This chart is for illustration purposes only; the actual fading rates or life expectancy for a specific print material will be different.

[b] The values in this table are the reciprocal of the average dark fading rates for chromogenic colour dyes relative to a steady state environment of 24 °C and 40 % RH; a relative fading rate equal to 1 is assumed during the time that the material is in use and not in storage.

Annex E
(informative)

Historic records for photographic prints

In facilities where historic photographic records are stored, care should be exercised when choosing the relative humidity level so that items in poor condition (those that are curled or have cracking or delaminating emulsions) are not physically stressed by low relative humidities in the range of 20 % to 30 %. Cycling between low relative humidity areas and higher relative humidity areas can exacerbate existing problems.

Storage at low temperature and/or low relative humidity can embrittle the emulsion or image layers making them more susceptible to physical damage during handling. Flexing or rough handling may damage embrittled prints, in addition to potentially exacerbating physical problems such as cracking emulsions. Because of this, all historic prints, especially those in poor condition, should be handled carefully when in storage at low temperature and/or low relative humidity.

Copies should be made for items that require frequent or extended use. This is especially true since the benefits of increased chemical stability of photographic materials gained by storage at low temperature or low relative humidity are quickly mitigated by frequent cycling and prolonged removal to higher temperatures and humidities.

Annex F
(informative)

Distinction between storage (record) copies and work (reference) copies

The distinction between photographic prints that are intended for storage and those intended for use has not always been clear. Work or reference copies, or copies for use, are the predominant photographic copies found in archives, record centres, libraries, and museum collections. Their value lies in their being available for ready reference. However, as a result of this use, they are subjected to physical damage such as tears, creases, abrasions, fingerprints, contamination with foreign materials, and exposure to excessive light and temperatures. Such work copies may become moisture-conditioned to the conditions of the working area, which may be quite different from the storage area where they are filed. In fact, physical distortions, such as curling, can occur in work copies if they are not reconditioned to the moisture conditions of the storage area. It is evident that work copies are not suitable for long-term preservation; they should not be considered as storage or record copies.

Where there is a need for extended storage of photographic prints having a permanent value, duplicates should be prepared for reference use. These duplicates should be kept in a collection area separate from the one in which original storage copies are stored. Original storage copies should meet the appropriate ISO requirements for the photographic material used and should be stored according to the recommendations of the appropriate International Standard. Original 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 prints are to be handled more than 10 times during their lifetime, work copies should be produced for use.

Annex G
(informative)

Air-entrained and gaseous impurities

When dust and other air-entrained solid particles are deposited on reflection prints, 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, ozone, peroxides, ammonia, paint fumes, solvent vapours, and other active compounds may cause deterioration of the base and a chemical degradation of the photographic image.

The most frequently encountered impurities, especially in urban and industrial atmospheres, are car exhaust fumes, nitrogen oxides, sulfur dioxide and ozone; small concentrations of these pollutants are likely to produce detrimental effects on photographic materials. Hydrogen sulfide is a compound that is very reactive with photographic silver images, even at low concentrations; it can occur in air conditioners or washers containing decomposed biological slime. Oxidizing gases, such as peroxides, are responsible for the local oxidation of image silver in fine-grain prints, which causes the formation of minute deposits of coloured colloidal silver and contributes to silver mirroring.

Suitable means for the removal of gaseous impurities are available, such as air washers operating with treated water for the elimination of sulfur dioxide, and chemical scavengers for the absorption of sulfur dioxide and hydrogen sulfide. These methods require consistent control and, in the case of chemical scavengers, expert processing.

Annex H
(informative)

Fire protection

Damage to reflection prints by high temperatures can occur even if the prints are not destroyed by fire. Although silver-gelatin images can withstand temperatures as high as 150 °C for several hours without significant loss in image quality, dye and diazo images may show some fading or change in colour balance. In addition to image loss, reflection prints may become so distorted at high temperatures that they can be viewed only with difficulty. Another danger to prints, as a result of exposure to high temperatures, is that of sticking or blocking to adjacent prints.

Steam generation and the resultant cooling effect is a design characteristic for the insulation of certain types of fire-resistant safes, insulated record containers, and vault doors. Prints should be protected against steam; otherwise, sticking, gelatin-emulsion melting, and severe distortion will result. For this reason, insulated record containers (Class 150) designed to seal the contents against steam are recommended (see clause 8).

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

Annex I
(informative)

Silver image degradation

Processed black-and-white silver images are susceptible to discolouration (microspots, mirroring or yellowing) when stored under adverse storage conditions or in unsuitable enclosures. The deterioration is caused by local oxidation of the image silver, resulting in ionic silver which is mobile. This mobile silver can migrate from its original site and be subsequently reduced to metallic silver and redeposited in a new location. When the silver is redeposited on the surface of the image layer, it results in a silver mirror. This appears as a metallic sheen when viewed by low-angle reflected light. When migration is confined to a localized area, this defect can appear as small reddish spots or microblemishes. Yellowing can be an overall or localized discolouration.

Possible oxidizing agents that cause this degradation are aerial oxygen, whose action is accelerated by moisture, and atmospheric contaminants such as peroxides, ozone, sulfur dioxide, hydrogen sulfide, or others that occur in industrial atmospheres. Peroxides may be present in most woods and may also be formed as a result of the ageing of paper inserts and cardboard containers commonly used in storing prints.In closed containers, various methods may be used to remove atmospheric pollutants using materials such as molecular sieves, chemical scavengers, and suitable corrosion inhibitors.

Processing and storage conditions play an important role in the development of discolouration or blemishes. Storage in cool, dry air that is free of oxidizing gases or vapours is usually an effective method of arresting or retarding the formation of discolouration or blemishes. Chemical conversion of the silver image provides excellent resistance to oxidizing gases [11].

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