INTERNATIONAL STANDARD

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Imaging materials — Reflection prints — Storage practices

Matériaux pour l'image — Tirages par réflexion — 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. 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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

This second edition cancels and replaces the first edition (ISO 18920:2000), which has been technically revised.

Introduction

This International Standard is one of a series of standards dealing with the physical properties and stability of imaging materials.

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

The stability and useful life of reflection prints (hereafter referred to as prints) depend on their physical and chemical properties, 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 prints during storage are as follows:

a) relative humidity and temperature of the storage environment;

b) hazards of fire, water and light exposure;

c) fungal growth and other micro-organisms;

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

e) physical damage;

f) proper processing;

g) enclosures and containers in contact with the print material.

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 can be used when it is desired to preserve information for as long as possible; 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 ability to maintain specified limits of temperature and relative humidity for both sets of storage conditions can be limited due to budgetary constraints, energy considerations, climatic conditions, building construction, etc. However, any deviation from the specified conditions will reduce the effectiveness of the storage environment. If such deviation is unavoidable, it is advisable to select the lowest possible storage temperature that can be maintained. In any event, the best preservation of prints will be attained with extended-term storage conditions.

This International Standard does not address the various strategies to upgrade substandard environments. However, institutions with substandard environments and restricted budgets can plan for the improvement of these environments as resources allow by judicious use of air conditioning, dehumidifiers (or humidifiers), air circulation and filtration. Although practicalities might force compromises, any improvement in poor conditions will add to the longevity of materials, even if they do not attain the life expectancies possible with the environments recommended in this International Standard. The subject of basic air conditioning principles, the various options and associated costs are outside the scope of this International Standard. There are many references on this subject.

The storage of traditional paper collections is not within the scope of this International Standard. However, many archives containing mixed recording media also include such collections. Archivists are encouraged to review the appropriate standards for those materials specified in ISO 11799 and in the International Standards listed in Clause 2.

The recommendations of this International Standard for the storage of 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.

It is understood that the archivist of a multiple media collection might be forced to limit the number of storage environments that can be provided. This compromise might be based on the value, physical size, quantity or legal requirements to maximize life expectancy of some collections relative to others. The issues of mixed media archives and recommendations for their storage are addressed in ISO 18934.

Imaging materials — Reflection prints — Storage practices

1 Scope

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

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

a) fibre-base paper;

b) RC (resin coated) paper;

c) pigmented and other types of plastic supports, e.g. polyester, cellulose acetate;

d) fabric, e.g. canvas, linen.

This International Standard is applicable to the following processed black-and-white silver gelatine prints:

1) 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 sulphur formulations;

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

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

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

i) chromogenic, washed and stabilized;

ii) silver dye bleach;

iii) dye transfer;

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

v) pigmented gelatine, e.g. carbon, carbro.

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

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

— thermal wax transfer;

— electro-photographic;

— dye and pigmented ink jet;

— swellable and porous-coated media supports;

— diazo.

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.

Recommendations for storage of photographic films and storage of processed photographic plates are given in ISO 18911 and ISO 18918 respectively.

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

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 18902, *Imaging materials — Processed imaging materials — Albums, framing and storage materials*

ISO 18916, *Imaging materials — Processed imaging materials — Photographic activity test for enclosure materials*

3 Terms and definitions

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

3.1
extended-term storage conditions
storage conditions suitable for the preservation of recorded information which has permanent value

3.2
fire-protective storage
facility designed to protect records against excessive temperatures, water and other fire-fighting agents, and against steam developed by insulation of safes or caused by the extinguishing of fires and collapsing structures

3.3
fire-resistant vaults
fire-resistant vaults as defined in appropriate national standards and regulations

NOTE See References [9] and [17].

3.4
insulated record containers (Class 150)
insulated record containers (Class 150) as defined in appropriate national standards and regulations

NOTE See References [7] and [12].

3.5
life expectancy
LE
length of time that information is predicted to remain in an acceptable state when placed in a system at 21 °C and 50 % RH

NOTE In the past, the term “archival” was used to define material that could be expected to preserve images forever, so that such images could be retrieved without significant loss when properly stored. However, as no such material exists, this is now a deprecated term and is no longer used in International Standards for imaging materials or in systems specifications.

3.6
medium-term storage conditions
storage conditions suitable for the preservation of recorded information for a minimum of 10 years

3.7
storage container
box or can be used to store prints

3.8
storage enclosure
any item in close or direct contact with recording material, such as folders, envelopes, sleeves, albums and mats

3.9
storage housing
physical structure supporting materials and their enclosures

NOTE This can 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 18916. This includes enclosures and containers that are in either direct or indirect contact with the prints. Prints may be stored in envelopes or sleeves of paper or plastic, file folders, folding cartons, boxes and albums, or may be matted. Prints shall be protected from unnecessary use and light exposure. Prints that are prone to light-induced fading, especially diazo and some colour processes, 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.

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. Glassine is not dimensionally stable when exposed to high relative humidity, although it may meet the other requirements specified in ISO 18902 and pass the photographic activity test.

Microclimates (sealed enclosures or cabinetry) shall be used where needed in order to maintain the desired moisture content of the prints where humidity control is inadequate in storage rooms or where cold storage vaults and units do not have humidity control, and to protect against gaseous and solid atmospheric contaminants. A variety of sealed vapour-proof housings, containers and cabinetry can provide this protection (as discussed in Table 1, 7.1.3.2 and Annex H).

The adhesive used for seams and joints shall also meet the requirements of ISO 18902 and ISO 18916. 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 gelatine, 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

Prints shall 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, e.g. anodized aluminium, 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. Finishes containing chlorinated or highly plasticized resins, or solvents

giving off gas from freshly applied finishes can adversely affect the image and base layers on prints. 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 aluminium are recommended. Metal housing materials that have been powder-coated (a layer of resin particles that are applied electro-statically 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 7.1 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, films and other media may be stored in the same storage room separately from each other. However, different types of material shall not be stored (interfiled) within the same enclosure or storage container.

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 fire and by water from floods, leaks and sprinklers, and from the steam released from masonry walls during a fire[7][9][12][17]. Storage rooms or vaults should be located above basement levels where possible. A special storage room separated from the work areas for prints of medium-term interest generally will not be required, provided the conditions recommended in 7.1.2 are maintained.

6.2 Extended-term storage rooms

For extended-term storage, the requirements of 6.1 shall be met.

In addition, 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 Temperature and humidity specifications for storage

7.1.1 General

See Annexes A, B, C, H and I.

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

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

Print process[ag]	Medium term storage		Extended term storage[a]	
	Maximum temperature	Relative humidity range	Maximum temperature[c]	Relative humidity range[bd]
	°C	% RH	°C	% RH
Black-and-white silver[e] Pigment (carbon, carbro) Dye imbibition (dye transfer) Silver dye bleach Dye/silver diffusion transfer (instant) Diazo Electro-photographic[f]	25	20 to 50	16	30 to 50
Thermal dye transfer (dye sublimation)[f]	25	20 to 50	2	30 to 50
Chromogenic dye			5	30 to 40
Ink jet (dye or pigment)[fh]				

[a] The values of Table 1 are the required conditions experienced by the photographic material. When micro-climates (housings or storage containers) are used that establish internal climate conditions, the environment of the exterior room need not necessarily meet the Table 1 conditions. See Annex H.

[b] As discussed in 7.1.3.3, certain gelatine emulsion photographs can be sensitive to RH levels of less than 30 % and can experience physical changes that can exacerbate existing deterioration such as flaking, cracking and curl. If these materials are present and RH above 30 % cannot be maintained, then microclimate storage housings or cabinetry shall be used to protect photographs from extremes in cycling or prolonged excursions below 30 %. Alternatively, a higher RH set point can be selected, e.g. 35 %, when a 5 % RH fluctuation within any 24-hour period does not exceed the lower RH limit of 30 %.

[c] Cycling of temperature shall not be greater than ± 2 °C over any 24-hour period. Some prints can become brittle at low temperatures and require careful handling when cold to avoid flexing that could cause cracks and image delamination (refer to 7.1.3.3).

[d] Cycling of relative humidity shall not be greater than ±5 % RH over any 24-hour period. However, the relative humidity shall not exceed 50 % RH. If RH cycling in the room cannot be controlled to this level, then microclimate storage housings or cabinetry shall be used to protect photographs from extremes in cycling or prolonged excursions to either high or low RH.

[e] If there is concern about the possibility of silver image deterioration due to atmospheric pollutants, poor quality enclosures, and/or excessively high temperature and humidity levels, a post-process chemical conversion treatment can be used to provide added protection (see ISO 18915).

[f] The rates of degradation and the potential for physical problems with extremely low temperature and/or low relative humidity storage is not well known for rapidly changing technologies such as thermal dye transfer (dye sublimation), thermal wax transfer, electro-photographic, and the many different ink jet image media (dye, pigment, wax) and base media (porous, swellable, plain paper). Factors such as chemical sensitivity, humidity fastness, and the stability of base materials may have a greater impact on longevity than thermal stability and light-fastness.

[g] Print life expectancy ratings by process type are not provided in this International Standard. For information on print stability, see Annex I.

[h] Some current ink jet prints, especially those utilizing inks made from stable pigment or optimized dyes printed onto stable supports as recommended by the manufacturer, may have very good image stability at temperatures warmer (up to 16 °C) than the recommended cold storage temperatures listed for extended-term storage. Where the identification of the type of ink and base cannot be determined, or where stable ink jet prints may have been interfiled with less stable materials, the colder temperatures listed shall be used unless prints can be separated by type for storage at different temperatures. The use of non-permanent paper supports or papers that are not optimized for the particular ink set can also adversely affect the overall stability of the print, requiring storage at cold temperatures.

7.1.2 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 any 24-hour period, and the peak temperature shall not exceed 30 °C. Some temperature fluctuation is permitted 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 %. Cycling of relative humidity shall not be greater than ±10 % over any 24-hour period within the specified range (relative

humidity shall not exceed 50 %). 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 7.1.3.3); prints may need to be equilibrated to a higher relative humidity prior to use.

7.1.3 Extended-term storage environment

7.1.3.1 Recommended environments for specific print media

A maximum storage temperature of 16 °C with a set point RH within the given range listed in Table 1 shall be used for black-and-white silver gelatine, silver dye bleach, dye/silver diffusion transfer (instant), dye imbibition (transfer), pigment (carbon, carbro) and diazo.

Cool storage between 2 °C and 5 °C with a set point RH within the range listed in Table 1 shall be used for monochrome and multi-colour chromogenic, thermal dye transfer (dye sublimation) and ink jet (see Annex H for cold storage practices). Excellent keeping behaviour has been obtained by storing colour prints at such low temperatures.

7.1.3.2 Impact of environment on media longevity

See Annexes C and H.

The rate of most chemical reactions, such as the degradation of bases and discolouration or fading of image layers, is lowered with decreasing temperature and decreasing relative humidity. Consequently, life expectancy is increased as either storage temperature or storage humidity is lowered. Added protection may be obtained for all print types by storage at temperatures lower than the maximum listed in Table 1. Moreover, a lower storage temperature can compensate for a higher humidity to provide the same life expectancy (see Annex C). For this reason, several relative humidity/temperature combinations can be used for an extended-term storage environment as specified in Table 1. Higher relative humidity levels can be employed if the average temperature is reduced, but the maximum relative humidity shall not exceed 50 %. Cycling of relative humidity shall be no greater than ±5 % RH over a 24-hour period. Cycling of temperature shall not exceed ±2C over a 24-hour period.

It is difficult to specify in this International Standard what the exact relative humidity and temperature of storage should be, since they depend upon the value of the prints, the past storage history, the length of time the prints are to be kept, the size of the storage or cold vaults, the cost of various options and the climate conditions where the facility is located. The cost/protection ratio is determined by the individual facility. Another very important factor to consider is the exact mix of photographic materials in the collection, i.e. whether photographic prints, plates or films are included and whether the materials are new or old. ISO 18934 addresses these issues in more detail and recommends storage environments for multiple media archives.

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 Annex C). Prints stored at temperatures significantly below room temperature will require some warm-up time before they can be used, in order to prevent the absorption or condensation of moisture on cold surfaces. This warm-up procedure requires that a vapour barrier be wrapped around the print or its housing prior to removal from the cold temperature area (see Annex H). Adequate time shall be provided to allow the total volume of prints to approach room temperature prior to removal of the vapour barrier and use of the prints. The required warm-up time may vary between 1 hour and 1 day, depending on package size (mass of the contents), degree of package insulation and temperature differential. The materials shall be allowed to slowly warm above the dew point prior to opening the vapour barrier. Insulated containers are useful for slowing the warm-up period when there is a large temperature difference between the cold storage and use conditions, such as with temperatures below 0 °C.

The recommended temperature and relative humidity conditions shall be maintained either within individual storage housings or within storage rooms containing such housings (see Annex H for cold storage practices and micro-environment storage). When the control of relative humidity in the macro-environment is not possible, the micro-environment shall be controlled using an airtight, moisture-proof housing from which as much free air as possible has been excluded. Prints which might have been exposed to relative humidities above 50 % for prolonged periods should be conditioned to a lower relative humidity in order to lower their moisture content prior to being placed in a sealed micro-environment package.