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**Photography — Processed reflection  
prints — Storage practices**

*Photographie — Tirages traités 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.

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

International Standard ISO 6051 was prepared by Technical Committee ISO/TC 42, *Photography*.

This fourth edition cancels and replaces the third edition (ISO 6051:1992), of which it constitutes a technical revision.

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

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## 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 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 reflection 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.

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

- humidity and temperature of the storage environment;
- hazards of fire, water, and light exposure;
- fungal growth;
- 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, on biological conditions conducive to fungal growth, and on 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 because the meaning of “archival” has become too ambiguous, 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 conditions can be used when it is desired to preserve information for at least 10 years. Extended-term conditions shall be used when it is desired to preserve information for as long as possible. Extended-term conditions shall be used when it is desired to preserve information for as long as possible. Extended-term 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 condition, 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 reflection prints encompass enclosures, housing, rooms, atmospheric conditions, fire protection, 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 reflection prints against natural or man-made catastrophes.

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# Photography — Processed reflection prints — Storage practices

## 1 Scope

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

**1.2** This International Standard covers reflection prints on the following opaque supports:

- fibre base paper;
- RC (resin coated) base paper;
- opaque plastic films (polyester, cellulose acetate, etc.).

This International Standard covers 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 instant prints);
- stabilization-processed (which contain the silver image as well as invisible, chemically stabilized silver halides);
- heat-processed.

This International Standard covers the following multi-colour and monochrome photographic prints:

- chromogenic, washed and stabilized;
- silver dye bleach;
- dye transfer;
- diffusion transfer (e.g. Polaroid instant prints, peel-apart or integral);
- pigmented gelatin (carbon, carbro, etc.).

This International Standard covers black-and-white and colour reflection prints made with the following systems:

- thermal dye transfer (commonly referred to as dye sublimation);
- thermal wax transfer;
- electrophotographic;
- ink jet;
- diazo.

**1.3** Recommendations for storage of photographic films are given in ISO 5466 and for storage of processed photographic plates in ISO 3897. Print material on translucent film supports intended to be viewed primarily by transmitted light should be stored in accordance with ISO 5466.

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

## 2 Normative references

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

ISO 5466:1995, *Photography — Processed safety photographic films — Storage practices*.

ISO 3897:1997, *Photography — Processed photographic plates — Storage practices*.

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

## 3 Definitions

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

**3.1 archival medium:** A 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 material or system specifications.

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

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

**3.4 fire-resistive vaults:** Fire-resistive vaults as defined in appropriate national standards and regulations ([1, 2] in annex J).

**3.5 insulated record containers (Class 150):** Insulated record containers [Class 150] as defined in appropriate national standards and regulations ([3, 4] in annex J).

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

**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:** A box or can used for storage of 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:** A physical structure supporting materials and their enclosures. 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 10214. This includes enclosures and containers that are in either direct or indirect contact with the prints. Reflection prints may be stored in envelopes or sleeves of paper or plastic, file folders, folding cartons, boxes or albums, or may be matted. Colour prints shall be protected from light exposure.

Generally, prints smaller than 28 cm × 36 cm in size may be stored vertically, but must 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 emulsion sides against back sides, never emulsion against emulsion.

Suitable plastic enclosure materials are uncoated polyester (polyethylene terephthalate), high-density polyethylene, and polypropylene. Other plastics may be satisfactory, but there has been no extended experience with such materials. Glassine envelopes and chlorinate, nitrated or highly plasticized sheeting shall be avoided.

Sealed enclosures shall be used, where needed due to adverse environmental or pollution conditions, to maintain the humidity levels of the prints, to protect against gaseous impurities in the atmosphere, 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 10214. The filing enclosure shall be so constructed 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 starch, and acrylic adhesives 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

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

The finish on the housing materials shall be durable and shall not 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 7.1 shall be provided with ventilation openings that permit access of air to the interior. Such openings shall not interfere with requirements for fire protection or water protection.

Different types of prints and films 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.

## 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, sprinklers, and the like. 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 7.1 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 Storage specifications (see annexes B, C and D)**

The storage temperature and relative humidity are given in table 1.

**Table 1 — Storage temperature and relative humidity**

Process	Medium-term storage		Extended-term storage <sup>1)</sup>	
	Maximum temperature °C <sup>2)</sup>	Relative humidity range % <sup>3)</sup>	Maximum temperature °C <sup>4)</sup>	Relative humidity range % <sup>5)</sup>
Black-and-white silver Silver dye bleach Dye/silver diffusion transfer (instant) Pigment Diazo	25	20 to 50	18	30 to 50
Chromogenic dye	25	20 to 50	2 <sup>6)</sup>	30 to 40
All others <sup>7)</sup>	25	20 to 50	-3	30 to 50

- 1) Formerly known as “archival storage”, see introduction. For storage of historic still-photographic prints, see annex E.
- 2) Cycling of the temperature shall not be greater than ± 5 °C over a 24 hour period; the peak temperature shall not exceed 30 °C.
- 3) Cycling of the relative humidity shall not be greater than ± 10 % over a 24 hour period.
- 4) Cycling of the temperature shall not be greater than ± 2 °C over a 24 hour 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.
- 5) Cycling of relative humidity shall not be greater than ± 5 % over a 24 hour period.
- 6) Generally, the 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 both standards and are suitable for storage of both types of materials: a maximum temperature of 2 °C and an RH of 30 % and a maximum temperature of 3 °C and an RH range of 30 % to 40 %. Older and historic chromogenic color 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).
- 7) 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.



### 7.1.1 Medium-term storage environment

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

The relative humidity for medium-term storage shall be between 20 % and 50 %, and cycling of the relative humidity shall not be greater than  $\pm 10$  % over a 24 hour period. The moisture content in prints shall not be greater than the moisture 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 may occur during handling (see annex E); prints may need to be equilibrated to a higher relative humidity prior to use.

### 7.1.2 Extended-term storage environment

The maximum temperature for extended-term storage shall be as specified in table 1, the variation of the temperature shall not be greater than  $\pm 2$  °C over a 24 hour period, and temperature fluctuation is allowable as long as the relative humidity stays within the specified limits.

The relative humidity for extended-term storage shall be as specified in table 1. The variation of relative humidity shall not be greater than  $\pm 5$  % over a 24 hour period. The moisture content in prints shall not be greater than the moisture 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. Low-temperature storage improves the stability of both the print support and the image.

For multi-colour 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 to prolong the useful life of the 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 specified relative humidity, then sealed in airtight containers and placed in cold storage. The required humidity conditioning period for fibre-based 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 for extended periods of time into higher temperature environments (see annexes A, D and E).

## 7.2 Environmental conditioning requirements

Properly controlled air-conditioning may be necessary to maintain 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] in annex J). They shall also follow recommendations for fire-resistive file rooms contained in appropriate national standards and regulations ([1, 2] in annex J). 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, which has been properly collaborated. 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 7.3) capable of removing dust particles 0,3 µm in size and larger, and are controlled to maintain the relative humidity specified in 7.1. 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 7.1, 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.

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## 7.3 Air purity (see annex F)

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Solid particles, which may abrade prints or react with the image, shall be removed by mechanical filters from air supplied to housings or to rooms used for extended-term storage. 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] in annex J). Filters shall be of a non-combustible type, meeting the construction requirements of appropriate national standards and regulations ([8, 9] in annex J).

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 containers 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 G)

Enclosure materials for fire-resistant storage shall be sufficiently fire-resistive 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. However, this melting or distortion shall not cause damage to the prints or prevent them from being removed from the enclosure.

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

When the quantity of prints is not too great, insulated record containers conforming to appropriate national standards and regulations may be used. A temperature of 66 °C and an interior relative humidity of 85 % shall not be exceeded when given 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/stored in another storage area.

## 9 Print identification, handling and inspection

### 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 10214.

### 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 to prevent flexing, creasing or sagging during use. Handlers shall wear thin, clean, cotton or nylon gloves.

### 9.3 Inspection

An adequate number of properly selected lot samples of prints should be inspected at 2 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. A record of the inspection results should be maintained to monitor changes in the appearance of prints. Periodic re-inspection shall be performed to ensure that corrective actions are effective.

Changes to note during inspection include

- Physical changes in the print (warping and other planar distortions, emulsion cracking and adhesion failure);
- visual changes (fading, microblemishes, colour change); or
- changes in the emulsion materials (embrittlement, discoloration).

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