

# INTERNATIONAL STANDARD

# ISO 6051

Third edition  
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## Photography — Processed photographic paper prints — Storage practices

*Photographie — Papiers photographiques traités — Directives pour  
l'archivage*

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Reference number  
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## Foreword

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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 third edition cancels and replaces the second edition (ISO 6051:1986), of which it constitutes a technical revision.

Annexes A, B, C, D, E and F of this International Standard are for information only.

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## Introduction

Photographic paper prints are important documentary and pictorial materials. There is a recognized need for information on safeguarding photographic prints having legal, scientific, industrial, artistic or historical value. The value of such records used in archives, museums, libraries, government, commerce and universities has focused attention on the care of such records to ensure their longest possible life [1].

Photographic prints are susceptible to degradation from many sources. The factors can be divided into three general categories.

### a) Nature of the photographic print

The stability of photographic print records depends on the physical and chemical nature of the print. Excellent keeping experience has been obtained with numerous photographic prints for a great many years. However, as yet no International Standard has been drafted on the stability of different types of photographic prints.

### b) Photographic processing of the print

For silver-gelatin type paper prints, the effect of residual thiosulfate will form the subject of a future International Standard.

### c) Storage conditions

The conditions under which photographic paper prints should be stored are extremely important for the preservation of prints and are the subject of this International Standard.

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

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

The recommendations of this International Standard also pertain to fire protection, print handling and inspection. This International Standard does not give recommendations concerning protection against natural or man-made catastrophes with the exception of fire and associated hazards which are sufficiently common to warrant inclusion of protective measures.

In addition to the specifications in this International Standard, good storage practices should consider the filing enclosure. These are covered in ISO 10214.

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# Photography — Processed photographic paper prints — Storage practices

## 1 Scope

1.1 This International Standard gives recommendations concerning the storage conditions, storage facilities, handling and inspection for all processed photographic paper prints in roll, strip, or sheet form, regardless of size.

This International Standard applies to wet processed silver-gelatin, thermally processed silver, diazo and colour papers.

1.2 The storage of photographic film and photographic plates requires different considerations and these are not covered in this International Standard but are covered in ISO 5466 and ISO 3897, respectively.

1.3 This International Standard applies to photographic paper records intended as storage copies; these copies being used only infrequently. It does not apply to work copies.

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

## 2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was 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 edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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 photographic paper print:** Paper sheet having a photographic image on a base consisting largely of cellulose fibres.<sup>1)</sup>

**3.2 fire-protection storage:** Facilities designed to protect photographic prints against excessive temperatures, water and other fire-fighting agents, steam developed by insulation of safes, and collapsing structures.

**3.3 insulated record container:** Container as defined in appropriate national standards and regulations.<sup>2)</sup>

**3.4 fire-resistant vault:** Vault as defined in appropriate national standards and regulations.<sup>3)</sup>

1) The photographic image may be in a layer coated either directly on the paper or on a pigmented layer (RC) previously applied to the paper, or on a resin layer (RC) previously applied to the paper. The photographic image may also be deposited on the paper surface without a binder layer.

2) Example: Class 150 of UL 72 [2].

3) Example: NFPA 232 [3].

**3.5 open enclosure:** Enclosure which is intended for physical protection against mechanical damage but neither lighttight nor airtight.

Folders, envelopes, cartons, sleeves, albums, wrappers or jackets are examples of open enclosures.

**3.6 protective enclosure:** Lighttight, impermeable container used for protection from outside factors such as reactive gases and moisture, including relative humidity changes.

Sealed envelopes are examples of protective enclosures.

## 4 Print enclosures

### 4.1 Classification of enclosures

Enclosures used for long-term storage of sheets or rolls of processed photographic paper prints may be divided into two broad classifications: open enclosures and protective enclosures.

### 4.2 Open enclosures

The purpose of open enclosures is to exclude dirt, to protect the print against mechanical damage and to facilitate identification and handling. They give limited access to ambient air. Therefore, the conditions of the surrounding air should be within the recommended limits of 7.1 to 7.4.

Prints in sheet form may be stored in envelopes of paper or plastic foil, folding cartons, file folders, or in strip jackets. Colour prints shall be stored in opaque envelopes or folders or otherwise protected from light exposure. When in direct contact with the surface of the photographic print, the paper or plastic material used for envelopes, sleeves, jackets, folders and cartons shall meet as a minimum requirement the specifications described in ISO 10214. Adhesives used in open enclosures shall also meet the requirements described in ISO 10214. The filing enclosure shall be constructed so that any seam or joint will be at the edge of the enclosure and not in contact with the print surface. For maximum storage life, photographic prints shall be in a clean condition before being placed in storage.

Prints which have labels on them, or which have been annotated, particularly with felt-tip pens, shall be interleaved with protective paper.

Rolls of photographic paper should be preferably stored in closed enclosures to provide protection against dirt and physical damage. Suitable enclosures are those with telescoping, slip-type or threaded twist-on lids. Closed enclosures are not necessarily airtight and can give limited access to ambient air. Therefore, if they are used, the humidity

of the ambient air shall not exceed the recommended limits.

Enclosures shall be non-corrodible, peroxide-free and not highly plasticized as described in ISO 10214. Rubber bands shall not be used for confining paper on reels or cores. If paper bands are used, the paper shall meet as a minimum requirement the specifications described in ISO 10214.

### 4.3 Protective enclosures

Protective enclosures shall be used where needed to maintain humidity within the limits specified (see clause 7), to protect against gaseous impurities in the atmosphere, or when low-temperature storage is used. Heat-sealable envelopes consisting of aluminium foil extrusion coated with clear polyethylene on the inside and laminated to a suitable paper sheet on the outside have been successfully used as sealed enclosures. To provide greater protection against pinholes, a double-bagging technique is recommended. Precautions should be taken in handling these envelopes so that they are not punctured.

Suitable enclosures for rolls of photographic paper are closed containers made from impermeable materials with friction-type or threaded, twist-on lids having an incorporated seal. Rubber gaskets shall not be used. Flip-top, hinged or telescoping lids can be used, but the joint shall be sealed by several wraps of pressure-sensitive adhesive tape having low gas permeability. Taped cans within heat-sealed foil bags provide additional protection from high humidity. If tape is used, routine retaping of joints every 2 years is recommended; in any case if the tape seal is observably deficient in integrity, it shall be replaced.

## 5 Storage housings

Photographic prints should be stored in closed housings such as drawers, or on shelves and racks enclosed by doors to provide protection from dust and dirt. Alternatively, open shelves and racks may be used if the prints are in closed containers. The storage housing materials shall be non-combustible and non-corrodible as described in ISO 10214. Because of their combustible nature and the possibility of producing active fading agents on ageing, materials made of wood, pressed-board, hardboard, particle-board and other natural materials shall be avoided.

The finish on housing materials shall be durable and shall not contribute deleterious effects to the stored photographic prints. Adverse effects can be produced by finishes containing chlorinated or highly-plasticized resins, or by freshly-painted or lacquered surfaces. Cabinets painted with oil-base paints shall

not be used for 3 months after painting as they can give off peroxides.

When air-conditioned individually, storage housings shall be arranged to permit interior circulation of air to all shelves and drawers holding prints to allow uniform humidity conditions. Storage housings located in rooms conditioned in accordance with 7.1 shall be provided with ventilation openings permitting access of air to the interior. Such openings shall not affect accordance with requirements for fire-protection storage or water protection.

Caution should be exercised in storing paper prints whose processing conditions are unknown or which have been treated or marked with materials of unknown stability. Intermixing of such prints with unaltered prints known to have been well processed in the same storage housing should be avoided.

## 6 Storage rooms

Rooms and areas used for print storage should be associated with rooms allowing facilities for inspection and viewing of the print. The inspection area should be maintained at the same temperature and humidity as the storage room, to avoid curling or distortion. Good housekeeping is essential. Walls and enclosures of air-conditioned spaces shall be designed to prevent condensation of moisture on interior surfaces and within walls, especially during periods of low exterior temperatures when the walls can be cooled below the dew point of the air. Provisions shall be made against print damage by water from floods, leaks, sprinklers, etc. Storage rooms or vaults should be located above basement level, where possible.

The value of photographic prints kept for long periods of time makes it advisable to provide a storage room or vault separate from temporary storage facilities, offices or work areas. It should be located as far as possible from an urban or industrial area where contaminants (see 7.3) may be present in harmful concentrations.

Storage rooms have been constructed in caves and mines and have proven very satisfactory when accepted requirements for the environmental conditions and air purity (see 7.4) have been met.

## 7 Environmental conditions

### 7.1 Humidity limits (see annex A)

The optimum limits for relative humidity of the surrounding air are 30 % to 50 % but short-term cycling between these extremes shall be avoided. Excursions above 50 % R.H. can have adverse af-

4) A conditioning time of 1 day is recommended for fibre base paper and 7 days for RC paper.

fects on the image stability of photographic prints. High moisture content of the air is conducive to mould growth which can completely destroy the image in time; and also the higher the moisture level, the greater is the effect of residual chemicals. A relative humidity lower than 30 % will minimize chemical deterioration, but can cause emulsion brittleness and print curl in the material stored. These latter effects may, however, be partially reversed by reconditioning to the proper humidity level.

### 7.2 Temperature limits (see annex B)

Probably the most important aspect of temperature is its effect on relative humidity, since a temperature variation may take the relative humidity beyond the acceptable range. Photographic papers shall not be stored above 30 °C for a prolonged period. This high temperature will accelerate the reactions that degrade the image. A temperature in the range of 15 °C to 20 °C is acceptable but daily cycling greater than 4 °C shall be avoided, by thermostatic means if necessary.

Added protection may be obtained for all prints by low temperature storage. A storage temperature of 2 °C or below is strongly recommended for colour images [4] [5]. Two methods may be used as follows.

- a) The prints may be conditioned to the recommended relative humidity<sup>4)</sup>, placed in hermetically-sealed enclosures after excluding as much air as possible, and then placed in below-freezing storage. Prints may be placed within two heat-sealed bags to provide good moisture protection. The use of such bags improves moisture protection but does not guarantee it. This procedure has the advantages of excellent keeping conditions and the use of reasonably-priced deep-freeze units. It is essential to limit as much as possible the volume of free air in the sealed enclosure.
- b) An alternative procedure is to use a storage room controlled at 2 °C and at the recommended relative humidity. This eliminates the requirement of sealed enclosures but does require an expensive installation. Low relative humidity is difficult and expensive to maintain at low temperatures.

The enclosure should be allowed to warm up to room temperature prior to opening to avoid moisture condensing on the print (see annex B). Cycling of temperature should be avoided.

The recommended humidity and temperature conditions may be maintained either within individual

storage housings or within storage rooms containing such housings.

### 7.3 Air-conditioning requirements

Properly controlled air-conditioning can be necessary for maintaining humidity and temperature within the limits specified for optimum storage. Slightly positive air pressure should be maintained within the storage room or vault.

Air-conditioning installations and automatic fire-control dampers in ducts carrying air to or from the storage vault shall be constructed and maintained on the basis of the recommendations contained in appropriate national standards and regulations<sup>5)</sup>. They shall also follow recommendations for fire-resistant file rooms contained in appropriate national standards and regulations<sup>6)</sup>.

Automatic control systems are recommended and they shall be checked frequently. Where air-conditioning is not practical, high humidities may be lowered by electrical refrigeration-type dehumidifiers, controlled with a hygostat. Inert desiccants, such as chemically-pure silica gel, may be used provided that the dehumidifier is equipped with filters capable of removing dust particles down to 0,3 µm in size and is controlled to maintain the relative humidity prescribed in 7.1. Dehumidification can be required in storage areas such as basements and caves that have inherently low temperatures and frequently exceed the upper humidity limit.

Humidification is necessary if the prevailing relative humidity is less than that recommended in 7.1 or if physical troubles, such as curl or brittleness, are encountered with active files. If humidification is required, a controlled humidifier shall be used. Water trays or saturated chemical solutions shall not be used because of the serious danger of over-humidification.

### 7.4 Air purity (see annex C)

Solid particles, which can abrade the surface or react with the image, shall be removed by mechanical filters from air supplied to housings or rooms used for storage. These mechanical filters should be preferably of dry-media type having an arrestance rating of not less than 85 % as determined by tests contained in appropriate national standards and regulations<sup>9)</sup>. Filters shall be of the non-combustible type, meeting the construction requirements of appropriate national standards and regulations<sup>7)</sup>.

Gaseous impurities such as sulfur dioxide, hydrogen sulfide, peroxide, ozone, acidic fumes, ammonia and

nitrogen oxides can cause degradation of the image [9]. They can be removed from the air by suitable washers or absorbers. An optimum storage vault should be located as far as possible from an urban or industrial area where contaminants can be present in harmful concentrations. Where practical, storage of prints in sealed enclosures in accordance with clause 4 will afford adequate protection.

As paint fumes can be a source of oxidizing contaminants, prints shall be removed from a storage area for a 3 month period when the area is freshly painted.

### 7.5 Light

Exposure to direct sunlight can lead to deterioration, especially in poorly-processed prints. Staining and fading can result. Light sources containing high levels of ultraviolet radiation should be avoided. Tungsten lights and ultraviolet-free fluorescent lamps are recommended for viewing or exhibiting. Alternatively, UV filters may be placed over the prints.

## 8 Fire-protection storage (see annex D)

During heating for 4 h at 150 °C in the package that is to be stored, enclosure materials for fire-protection storage shall not ignite or release more reactive fumes than the print itself does. Many enclosure materials will melt or become badly distorted at this temperature. However, this melting or distortion shall not cause damage to the print or prevent it from being removed from the enclosure.

For protection against fire and associated hazards, the prints shall be placed in enclosures in either fire-resistant vaults or insulated record containers. If fire-resistant vaults are used, they shall be constructed in accordance with recommendations contained in appropriate national standards and regulations<sup>9)</sup>.

When the quantity of prints is not too great, insulated record containers conforming to appropriate national standards and regulations<sup>2)</sup> may be used. An interior temperature of 60 °C and an interior relative humidity of 85 % shall not be exceeded when given a fire exposure test from 1 h to 4 h in duration depending on the classification of the record container. Insulated record containers shall be situated on a ground-supported floor if the building is not fire-resistant.

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

5) Example: NFPA 90A [6].

6) Example: Stain test of ASHRAE Standard 52-68 [7].

7) Example: Class 1 construction of UL 900 [8].

## 9 Print handling and inspection

### 9.1 Handling

Proper handling of prints is important. Some prints are used frequently, generating damage, emulsion scratches and imposing critical handling and filing requirements.

Good housekeeping and cleanliness are essential. Prints should be handled by their edges and the wearing of clean, thin cotton gloves by the handlers is recommended.

### 9.2 Inspection

A number of different representative samples of prints should be inspected every 2 years. If deviations from recommended temperature and relative humidity ranges have occurred, inspection should

be made more frequently. A sampling plan established in advance should be used and a different lot should be inspected each time. Deterioration of either prints or enclosure materials shall be noted.

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

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

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## Annex A (informative)

### Humidity during storage

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

Storage systems which do not allow relative humidities to rise above 50 % should be used. Prolonged exposure to conditions above 60 % relative humidity will tend to damage or destroy the gelatin emulsion layer due to growth of fungus and will eventually cause softening and sticking of the emulsion. High humidity exposure will also accelerate any effects

of residual processing chemicals (for example, thiosulfate) on the stability of silver images and will impair the stability of dye images.

Consistent exposure to humidity below 20 % relative humidity will tend to produce a temporary brittleness in gelatin emulsions but flexibility can be restored by reconditioning to 30 % relative humidity or higher. Prints having a low moisture content are apt to develop static charges causing attraction of dust particles, but this difficulty can be avoided by discharging during handling and printing.

## Annex B (informative)

### Temperature during storage

Continuous temperatures above approximately 40 °C can accelerate fading of dye images. While gelatin becomes brittle at low temperatures (below 0 °C), flexibility is restored upon return to room temperature. Storage temperatures below the dew point of air can produce condensation of moisture upon print surfaces unless container and contents are brought above the dew point temperature before removal of the print. The required warm-up time can

amount to several hours, depending on the size of the package and the temperature differential.

An important aspect of temperature is its effect on relative humidity of the storage area. Low storage temperature can raise the relative humidity if the storage area is not humidity-controlled. This can cause conditions beyond the range of recommended humidities for proper storage, and therefore sealed containers should be used.

## Annex C (informative)

### Air-entrained and gaseous impurities

When dust and other air-entrained solid particles are deposited on photographic prints, they can interfere with legibility and produce scratches. Reactive types of dust can cause fading or staining of the image layer. Gaseous impurities such as sulfur compounds, peroxides, paint fumes and other active compounds can cause deterioration of the base and a chemical degradation of the photographic image. The most frequently encountered impurity, especially in urban and industrial atmospheres, is sulfur dioxide and small concentrations are likely to produce detrimental effects. Hydrogen sulfide is not a common impurity but is a very active one even at

low concentrations; it can occur in air washers containing decomposed biological slime. Oxidizing gases, such as peroxides, are responsible for the local oxidation of image silver in fine grain images [9] [10] [11] [12], causing formation of minute deposits of coloured colloidal silver.

Suitable means for removal of gaseous impurities are available, such as air washers operating with treated water for elimination of sulfur dioxide and activated carbon for the absorption of sulfur dioxide and hydrogen sulfide [10]. These require consistent control and, in the case of activated carbon, expert processing.

## Annex D (informative)

### Fire protection

Damage to photographic paper records by high temperature can occur even if the print is not destroyed by fire. While silver-gelatin images can withstand temperatures as high as 150 °C for several hours without significant loss in image quality, dye images can show some fading or change in colour balance. Thermally processed silver images will have image degradation at temperatures above 50 °C. In addition to image loss, photographic prints can become severely distorted at high temperatures so that they can only be viewed or copied with difficulty. One danger to prints, as a result of high temperature exposure, is that of sticking or blocking of adjacent sheets or laps.

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

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

**Annex E**  
(informative)

**Microscopic blemishes**

Some processed photographic prints while in storage have developed coloured spots or blemishes. These spots are caused by local oxidation of image silver, resulting in the formation of minute deposits of colloidal silver. Possible oxidizing agents causing this degradation are aerial oxygen, whose action is accelerated by moisture, and atmospheric contaminants such as peroxides, ozone, sulfur dioxide, hy-

drogen sulfide and others occurring in industrial atmospheres [11] [12]. Peroxides can be present in some types of wood and can also be formed as a result of ageing of paper inserts and cardboard containers commonly used in storage. Storage in cool, dry air that is free of oxidizing gases or vapours is usually an effective means for arresting or retarding the formation of blemishes [13].

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