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Imaging materials — Multiple media archives — Storage environment

Matériaux pour l'image — Archives multimédia — Environnement de stockage

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 18934 was prepared by Technical Committee ISO/TC 42, *Photography*.

This International Standard is one of a series of International 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).

Introduction

Over the years, technical committees ISO/TC 36 and ISO/TC 42 of the International Organization for Standardization have published ISO storage standards specific to individual materials. Many of these temperature/relative humidity recommendations are based on laboratory studies using Arrhenius type projections that allow extrapolation of high temperature incubation tests to recommended storage environments at reduced temperatures. This also allows a prediction of the life expectancy of materials. This approach and the resulting analysis are logical when each medium is considered by itself. The individual ISO storage standards are sound and the predicted life expectancies have been consistent with practical experience. However, the storage conditions can differ widely for various media and reflect differences in their inherent stability. The extended-term storage conditions recommended in the various standards provide wide humidity ranges and set only a maximum temperature limit with considerable overlap in allowed environmental conditions across several media types.

In the real world, archivists and curators frequently are faced with the task of storing many types of material, such as film, prints, tapes, etc. Archives often contain media that cannot be separated without destroying the integrity of the collection. In other archives, one collection can consist primarily of one medium, but there are many collections each with different media. In either situation, it may not be practical or realistic for the archivist to provide a number of different storage environments that are optimized for each material. The cost and inconvenience would be prohibitive; moreover, records of the same or similar subject matter are usually stored in close proximity to facilitate reference, not by the type of medium. The archivist of a multiple media collection may be forced to limit the number of storage environments that can be provided. In some cases, this means some deviation from the ISO storage recommendations and can compromise the life expectancies specified in the standards. This compromise can be based on the value, physical size, quantity, or legal requirements to maximize life expectancy of some collections relative to others.

This International Standard provides an assessment of the keeping qualities for four storage environments. As such, it is most useful for storage facilities which house different types of materials, but does not override the ISO recommendations for single medium collections.

This International Standard does not discuss the various strategies to upgrade substandard environments that deviate from those recommended by ISO standards. However, institutions with substandard environments and restricted budgets should 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 can force compromises, any improvement of poor conditions will add to the longevity of materials, even if they do not attain the life expectancies possible with the environments recommended in the ISO standards. A discussion of basic air conditioning principles, the various options and the associated costs are outside the scope of this International Standard. There are many references on this subject.

Imaging materials — Multiple media archives — Storage environment

1 Scope

This International Standard provides suggested guidelines for four temperature and humidity macroenvironments for archives that contain a variety of recording media, based on the corresponding ISO storage standards for those media. Whenever possible, it is advisable to follow the storage environments in the ISO storage standards. This International Standard does not replace these ISO storage standards. In addition to environment recommendations, those standards also include other vital information pertinent for the long-term keeping of recording materials, such as inspection, housing, and handling guidelines. Although microenvironments within a storage enclosure can be dependent upon the macroenvironment, they are not the focus of this International Standard.

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 (see References [1] and [2] in the Bibliography) for those materials. Nitrate-base photographic films are also included in this International Standard, since they are often stored together with other materials in spite of the fact that nitrate films represent a fire hazard and they need to be stored in accordance with the National Fire Protection Association standard[3] in the United States, or other applicable national standards. Moreover, fumes from decomposing nitrate film and acetate-base film can have very detrimental effects on other materials stored in the same area.[11] It is necessary to isolate such films in a separate storage area.

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 10356, *Cinematography — Storage and handling of nitrate-base motion-picture films*

ISO 18911, *Imaging materials — Processed safety photographic films — Storage practices*

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

ISO 18920, *Imaging materials — Processed photographic reflection prints — Storage practices*

ISO 18923, *Imaging materials — Polyester-base magnetic tape — Storage practices*

ISO 18925, *Imaging materials — Optical disc media — Storage practices*

3 Terms and definitions

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

3.1
conditioning
exposure of a specimen to air at a given relative humidity and temperature until equilibrium is reached

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

3.3
relative humidity
RH
ratio, defined as a percentage, of the existing partial vapour pressure of water to the vapour pressure at saturation

NOTE It is usually, but not always, equal to the percentage of the amount of moisture in the air to that at saturation.

3.4
life expectancy
LE
length of time that information is predicted to be acceptable in a system after dark storage at 23 °C and 50 % RH

3.5
LE designation
rating for the "life expectancy" of recording materials and associated retrieval systems

NOTE The number following the LE designation is a prediction of the minimum life expectancy in years, for which information can be retrieved without significant loss when stored at 23 °C and 50 % RH, e.g. LE-100 indicates that information can be retrieved after at least 100 years storage.

3.6
macro-environment
atmospheric conditions (temperature, relative humidity, and pollutants) in a large area in which records are kept

3.7
magnetic tape
material consisting of a magnetic-sensitive layer coated on a thin plastic support that can produce a magnetic recording

3.8
medium-term storage conditions
storage conditions suitable for the preservation of recorded information for a minimum of 10 years

3.9
micro-environment
atmospheric conditions (temperature, relative humidity, and pollutants) inside a storage enclosure in which records are kept

3.10
optical disc
disc that will accept and retain information in the form of marks or density modulations in a recording layer that can be read with an optical beam

3.11
photographic film
material consisting of one or more radiation-sensitive layers coated on transparent or translucent plastic that yields a visible image

3.12
photographic paper
material consisting of one or more image-forming layers coated on plain paper, paper with a white pigmented layer, paper sandwiched between white opaque resin layers or on other opaque supports

3.13
photographic plate
material consisting of one or more radiation-sensitive layers coated on a rigid support, such as glass or metal, that yields a visible image

3.14
photographic print
a photographic copy, usually made from a negative, consisting of a layer (or layers) containing a positive image

NOTE The image layers can be coated on a white opaque, semi-transparent, or transparent support and the images viewed by reflected or transmitted light.

3.15
recording material
medium that receives images, text or audio information which can subsequently be viewed or retrieved

3.16
storage environment
conditions for storing materials, i.e. temperature, relative humidity, cleanliness of facilities and atmospheric pollutants

4 Recommendations

4.1 Temperature range

The guidelines for extended-term storage conditions given in this International Standard specify four different temperature ranges for the storage of mixed media collections:

— room;

— cool;

— cold;

— subzero (see Table 1).

“Room” conditions are satisfactory for materials that are considered to be chemically stable, such as black-and-white silver and carbon images on polyester base, glass, and paper. “Cool” conditions are suitable for materials whose stability may be compromised at cold temperatures (magnetic media) and for unstable materials (e.g. black-and-white acetate film) provided a low RH can be maintained. “Cold” conditions are recommended for unstable materials, such as colour photographs of all types and cellulosic based films. “Subzero” conditions should be used to obtain the maximum life for all materials that can tolerate this environment. It should also be used for unstable materials which have little tolerance for higher temperatures. In some situations, chemical degradation may have already started as evidenced by the vinegar odour of deteriorating acetate-base photographic films, by rusted cans or image degradation for nitrate base films, or by colour deterioration. These materials should always be stored in the “subzero” environment.

The archivist should choose the temperature range which is most suitable for the specific collection with the objective of obtaining a temperature range as close as possible to the ISO recommendations. Comparisons of the ISO storage conditions given in the standards for specific materials with the corresponding guidelines in this International Standard are given in Table 2. Consideration should be given to maintaining a lower set point temperature during normally cool periods of the year. This may offset slightly higher temperatures in other seasons where it is impractical to maintain the low temperature.

Table 1 — General temperature categories for long-term storage conditions

Condition[a]	Temperature range °C
Room	16 to 23
Cool	8 to 16
Cold	0 to 8
Subzero	−20 to 0

[a] Assuming 30 % RH to 50 % RH for each condition.

Table 2 — ISO long-term storage conditions

Base material	Recording layer	ISO Standard	RH % Min.	RH % Max.	Max. temperature °C
Glass plate	BW photo	18918	30	40	18
Nitrate	BW photo	10356	20	30	2
Acetate	BW photo	18911	20	50	2
			20	40	5
			20	30	7
	Colour photo	18911	20	50	−10
			20	40	−3
			20	30	2
Polyester	BW photo	18911	20	50	21
	Colour	18911	20	50	−10
			20	40	−3
			20	30	2
	Magnetic tape	18923	15	50	11
			15	30	17
			15	20	23
Paper	BW photo	18920	30	50	18
	Colour	18920	30	40	2
	Ink jet	18920	30	50	−3
Polycarbonate	CD	18925	20	50	23

4.2 Temperature cycling

Cycling of temperature should be controlled under two situations, namely when there is concern about physical damage and when the temperature cycling causes the high temperature to be outside the ISO recommendations, which would be detrimental for chemical stability. Temperature conditioning times are generally quite rapid.

Physical damage is possible because of the differences in thermal coefficients of expansion or contraction between different layers of the laminate which can result in adhesive failure. Optical discs may be susceptible to this problem because of the thickness of the component layers.

Temperature cycling within the recommended limits should not be a problem unless the average temperature is near the upper limit. Under these conditions, the variation should not exceed the ± 3 °C over a 24-h period, as indicated in ISO standards. Temperature excursions below the limit given in Table 1 are not ordinarily a problem since lower temperatures improve chemical stability. Exceptions may be optical discs, glass plates, and magnetic tape, which may exhibit physical defects.

4.3 Relative humidity range

As seen in Table 2, the relative humidity ranges in ISO standards for various media fall between 15 % to 50 %, depending on temperature levels, with no more than a ± 5 % deviation over a 24-h period. For almost all materials, a safe average relative humidity that balances chemical stability with physical stability for handling is between 30 % RH and 50 % RH. However, the chemical stability of many materials is improved by lowering the upper relative humidity level.

Periodic non-standard conditions can be partially alleviated with periods of better conditions to achieve a life expectancy that is greater than that of the poor condition alone (see References [4], [5] and [6] in the Bibliography). In some climates, it may be possible to maintain the range of 30 % RH to 40 % RH during some seasons which would partially offset the effect of higher ranges in other seasons.

4.4 Relative humidity cycling

Cycling of the relative humidity should be controlled under the same two situations discussed for temperature cycling, if it can cause mechanical damage and if it results in humidities outside the recommended limits, which would compromise chemical stability.

Mechanical damage or loss of the physical integrity of the media can be a concern for older photographic products with poor emulsion-base adhesion, such as historic glass plates. Adhesion failure between the laminate of optical discs may also be problem, because of differences in the humidity contraction of the different layers.

Generally cycling humidities between 30 % RH and 50 % RH is not critical, unless the average value is close to the upper limit. Cycling could result in appreciable excursions beyond the limit. This will depend upon the magnitude of the cycling, the time spent deviating from the recommended level and the type of enclosure used. Table 3 illustrates the tremendous difference in moisture-conditioning time for different materials and enclosures.

When the enclosure does not provide appreciable moisture protection and relative humidity, cycling is important, cycling should not exceed the ± 5 % RH recommendation of ISO over a 24-h period. However, when plastic boxes or metal cans are used, it is unnecessary to provide very strict humidity control (see References [7] and [8] in the Bibliography). Humidity cycling as high as ± 20 % RH over a 24-h period will not be detrimental. It is important that the moisture content of the media remain within the range of 30 % RH to 50 % RH.

Table 3 — Typical times to 50 % moisture equilibrium at 21 °C

Material or closure	Time[a] days	Reference in Bibliography
16 mm roll of photographic film in metal can[b]	20	[7]
35 mm roll of photographic film in cardboard box[b]	3	[8]
35 mm roll of photographic film in metal can	40	[8]
35 mm roll of photographic film in plastic box	130	[8]
150 sheet film stack in cardboard box	3	[8]
150 sheet film stack in metal box	15	[8]
¾ in magnetic tape without enclosure	1	[9]
¾ in magnetic in cassette	2	[9]

a For example, if original moisture level is at 20 % RH and material is placed in a 50 % RH environment, the times indicated are to reach a moisture equilibrium of 35 % RH.

b Closed and not-sealed cans and boxes.

5 Selecting environmental conditions for mixed media archives

Many institutions have collections in which one or two media types predominate, such as photographic prints on paper base and still film negatives, or magnetic audio-visual tapes and motion picture films. Other collections may also include small quantities of other materials in addition to the predominant type. These may not be segregated by type because they were acquired that way or because it was not possible to segregate them without disrupting their organizational structure or losing informational content.

All institutions need to balance the desired or legal requirements in order to maximize the life expectancy of their collections with the available resources. Generally, the more cost-effective solution is to minimize the number of storage environments. The ISO storage standards specify different environmental conditions for various media. As indicated in 4.1 and Table 1, ISO storage recommendations for various media fall into four broad temperature ranges. When maximum life expectancy is desired, it is best to store the media according to the relevant ISO recommendations. These are based on projected life expectancy models for relatively fresh materials. Older media typical of historic collections may have already undergone a certain amount of deterioration, depending on past storage conditions and age, and may require colder storage temperatures.

In selecting environmental conditions for multiple media collections, the decision may depend on factors such as predominant media types, the relative importance of various collections, the collection size of one media type, and the current degree of deterioration. For example, if the majority of collections are B/W paper or polyester film in good condition with very small amounts of colour, one room condition storage area should suffice, with a small refrigerator or freezer unit for the more unstable colour materials. As resources allow, the lower temperature and RH levels of each condition should be provided for optimal results.

The critical decision for the collection manager hinges on the consequences of selecting a storage environment that does not match the ISO recommendations. The suitability of each environment for the various materials is summarized in Table 4. Also indicated are the possible consequences if storage conditions are not recommended. These consequences are described by the following qualitative terms:

— “very good” indicates that the life expectancy will be greater than obtained by following the ISO standard for that specific material;

— “good” indicates life expectancy equalling the ISO recommendation;

— “fair” denotes a quality which is satisfactory for moderate keeping times but not equal to that obtained by following the ISO conditions;

— “no” results in unsatisfactory keeping.

Table 4 — Suitability of storage environment for media stability

Storage conditions		Media											
		Glass plates	Nitrate[a]	Acetate[a]		Polyester		Photo prints		Electrophoto-graphic, dye sub, ink jet prints	Magnetic		CD, DVD
				B&W	Colour	B&W	Colour	B&W	Colour		Acetate[a]	Polyester	
Room	16 °C to 23 °C 30 % RH to 50 % RH	Fair	No[c]	No[c]	No[c, d]	Good[g]	No[d]	Good[g]	No[d]	No[h] to good	No[c, e]	No[e]	Fair
Cool	8 °C to 16 °C 30 % RH to 50 % RH	Good	No[c]	No[c]	No[c, d]	Good	No[d]	Good	No[d]	No[h] to good	Fair[c]	Good	Good
Cold	0 °C to 8 °C 30 % RH to 50 % RH	Very good	Good	Good	Good[i]	Very good	Good[i]	Very good	Good[i]	Good	Good	Fair	Good
Subzero	–20 °C to 0 °C 30 % RH to 50 % RH	No[b]	Very good	Very good	Very[i] good	Very good	Very[i] good	Very good	Very[i] good	Very good	No[f]	No[f]	No[b]

a Shall be stored at subzero temperatures if there are advanced signs of decay, such as discoloration, outgassing, rusted cans.

b Brittleness or delamination are possible.

c May result in base degradation.

d Image fade or colour balance shift may occur.

e Degradation of magnetic layer binder is a concern.

f Lubricant separation from binder is possible.

g Image change may occur if improperly processed or stored in enclosures that emit peroxides.

h Staining, yellowing, and dye migration are potential problems.

i See Reference [10] in Bibliography.

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 present 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	*Imaging materials — Processed silver-gelatin type black-and-white films — Specifications for stability*	18901
10214	*Imaging materials — Processed photographic films, plates and papers — Filing enclosures and storage containers*	18902
6221	*Imaging materials — Films and paper — Determination of dimensional change*	18903
5769	*Imaging materials — Processed films — Method for determining lubrication*	18904
8225	*Imaging materials — Ammonia-processed diazo photographic film — Specifications for stability*	18905
543	*Imaging materials — Photographic films — Specifications for safety film*	18906
6077	*Imaging materials — Photographic films and papers — Wedge test for brittleness*	18907
8776	*Imaging materials — Photographic film — Determination of folding endurance*	18908
10977	*Photography — Processed photographic colour films and paper prints — Methods for measuring image stability*	18909
4330	*Imaging materials — Photographic film and paper — Determination of curl*	18910
5466	*Imaging materials — Processed safety photographic films — Storage practices*	18911
9718	*Imaging materials — Processed vesicular photographic film — Specifications for stability*	18912
	Imaging materials — Permanence — Vocabulary	18913
	Imaging materials — Photographic film and papers — Method for determining the resistance of photographic emulsions to wet abrasion	18914
12206	*Imaging materials — 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	*Imaging materials — Processed photographic plates — Storage practices*	18918

Table A.1 (*continued*)

Current ISO number	Title	New ISO number
14806	*Imaging materials — Thermally processed silver microfilm — Specifications for stability*	18919
6051	*Imaging materials — Processed photographic reflection prints — Storage practices*	18920
15525	*Imaging materials — Compact discs (CD-ROM) — Method for estimating the life expectancy based on the effects of temperature and relative humidity*	18921
	Imaging materials — Processed photographic films — Methods for determining scratch resistance	18922
15524	*Imaging materials — Polyester-base magnetic tape — Storage practices*	18923
15640	*Imaging materials — Test method for Arrhenius-type predictions*	18924
16111	*Imaging materials — Optical disc media — Storage practices*	18925
16112	*Imaging materials — Information stored on magneto-optical (MO) discs — Method for estimating the life expectancy based on effects of temperature and relative humidity*	18926
	Imaging materials — Recordable compact disc systems — Method for estimating the life expectancy based on the effects of temperature and relative humidity	18927
10331	*Imaging materials — Unprocessed photographic films and papers — Storage practices*	18928
	Imaging materials — Wet-processed silver-gelatin type black-and-white phototgraphic reflection prints — Specifications for dark storage	18929
	Imaging materials — Protocols for outdoor weathering experiments	ISO/TR 18930
	Imaging materials — Recommendations for humidity measurement and control	ISO/TR 18931
	Imaging materials — Adhesive mounting systems — Specifications	18932
	Imaging materials — Magnetic tape — Care and handling practices for extended usage	18933
	Imaging materials —Multiple media archives — Storage environment	18934
	Imaging materials — Colour images on paper prints — Determinination of indoor water resistance of printed colour images	18935
	Imaging materials — Colour films and reflection colour prints — Methods for measuring thermal (dark) stability	18936
	Imaging materials — Reflection colour prints — Methods for measuring light stability	18937
	Imaging materials — Optical discs — Care and handling practices for extended usage	18938

Annex B
(informative)

Stability of electrophotographic, dye sub, inkjet prints

Electrographic, thermal transfer dye sub diffusion and pigment-based inkjet prints have good dark stability, with the useful life determined by the permanence of the paper base. Dye-based inkjet prints generally also have good dark stability. However, these prints may be vulnerable to atmospheric pollution and may suffer from humidity-induced dye migration. Prints made with other processes, such as thermal leuco-dye, may deteriorate over time and may require cold or subzero conditions for long-term preservation.

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