BS ISO 18934:2011

BSI Standards Publication

Imaging materials — Multiple media archives — Storage environment

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National foreword

This British Standard is the UK implementation of ISO 18934:2011. It supersedes BS ISO 18934:2006 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CPW/42, Photography.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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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 second edition cancels and replaces the first edition (ISO 18934:2006), which has been technically revised.

Introduction

Historically, technical committees ISO/TC 36 and ISO/TC 42 have published ISO storage standards specific to individual materials. Many of these temperature and 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 might 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 might 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 that house different types of materials, but does not override the ISO recommendations for single medium collections.

Institutions with substandard environments and restricted budgets are encouraged to 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. Basic air conditioning principles, the various options and the associated costs are not addressed in 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 macro-environments for archives that contain a variety of recording media, based on the corresponding ISO storage standards for those media. Whenever possible, this International Standard recommends that users follow the storage environments in the ISO storage standards.

This International Standard does not replace those ISO storage standards. In addition to environment recommendations, those standards also include other vital information pertinent to 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 macro-environment, 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]) for those materials.

Nitrate-base photographic films are also included in this International Standard, since they are often stored together with other materials.

NOTE Nitrate-base films represent a fire hazard and 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 detrimental effects on other materials stored in the same area[11]. A solution to this problem is to isolate such films in a separate storage area.

This International Standard does not address the various strategies to upgrade substandard environments that deviate from those recommended by ISO standards.

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 — 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 that has permanent value

3.3
life expectancy
LE
rating for the life expectancy of recording materials and associated retrieval systems

NOTE The number following the LE symbol is a prediction of the minimum life expectancy in years for which information can be retrieved without significant loss when stored at the conditions defined in the relevant standards.

EXAMPLE LE-100 indicates that information can be retrieved after at least 100 years storage.

3.4
macro-environment
atmospheric conditions (temperature, relative humidity, and pollutants) in a large area in which records are kept

3.5
magnetic tape
material consisting of a magnetic-sensitive layer coated on a thin plastic support that can produce a magnetic recording

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

3.7
micro-environment
atmospheric conditions (temperature, relative humidity, and pollutants) inside a storage enclosure in which records are kept

3.8
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

3.9
photographic film
material consisting of one or more radiation-sensitive layers coated on transparent or translucent plastic that yields a visible image

3.10
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

3.11
photographic print
material consisting of one or more radiation-sensitive layers coated on paper, paper with a pigmented layer, paper with a resin layer, or on an opaque support, that yields a visible image

NOTE This term is now used to describe all manner of printed photographic images.

3.12
recording material
medium that receives images, text or audio information which can subsequently be viewed or retrieved

3.13
relative humidity
RH
ratio, defined as a percentage, of the existing partial vapour pressure of water to the vapour pressure at saturation at a given temperature

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

3.14
storage environment
conditions for storing materials, i.e. temperature, relative humidity, cleanliness of facilities and atmospheric pollutants

NOTE Ideally the storage environment will meet the relevant ISO criteria.

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 can be compromised at cold temperatures (magnetic media) and for unstable materials (e.g. black-and-white acetate film) provided that a low RH can be maintained.

Cold conditions are recommended for unstable materials, such as some colour photographs 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 might 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 that 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 can 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 %		Max. temperature
			Min.	Max.	°C
Glass plate	BW photo	ISO 18918	30	40	18
Nitrate	BW photo	ISO 10356	20	30	2
Acetate	BW photo	ISO 18911	20	50	2
			20	40	5
			20	30	7
	Colour photo	ISO 18911	20	50	−10
			20	40	−3
			20	30	2
Polyester	BW photo	ISO 18911	20	50	21
	Colour	ISO 18911	20	50	−10
			20	40	−3
			20	30	2
	Magnetic tape	ISO 18923	15	50	11
			15	30	17
			15	20	23
Paper	BW photo Electro-photographic Silver dye bleach	ISO 18920	30	50	16
	Chromogenic colour Inkjet Dye-sub	ISO 18920	30 30	50 40	2 5
Polycarbonate	CD	ISO 18925	20	50	23

4.2 Temperature cycling

Cycling of temperature should be controlled under two situations: when there is concern about physical damage and when the temperature cycling causes the high temperature to be outside the ISO recommendations that 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 that can result in adhesive failure. Optical discs might 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 $\pm$ 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 that might 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 $\pm$ 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 some climates, it might be possible to maintain the range of 30 % RH to 40 % RH during some seasons that 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 might also be problematic, 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, although it should not exceed the $\pm$ 5 % RH recommendation 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]). Humidity cycling as high as $\pm$ 20 % RH over a 24 h period will not be detrimental. It is important that the moisture content of the media remains 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 the original moisture level is at 20 % RH and the 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 might 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 might have already undergone a certain amount of deterioration, depending on past storage conditions and age, and might require colder storage temperatures.

In selecting environmental conditions for multiple media collections, the decision might 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 media, 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 in a non-recommended environment. These consequences are described by the following qualitative terms:

— “very good” indicates that the life expectancy will be greater than that 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	Good	Good
Subzero	–20 °C to 0 °C 30 % RH to 50 % RH	Very good[b]	Very good	Very good	Very[i] good	Very good	Very[i] good	Very good	Very[i] good	Very good	Good	Good	No[i]

[a] These shall be stored at subzero temperatures if there are advanced signs of decay, such as discoloration, outgassing, rusted cans, brittle film base or image deterioration.

[b] Brittleness or delamination are possible with older plates.

[c] This can result in base degradation.

[d] Image fade or colour balance shift can occur for chromogenic colour, thermal dye transfer and some ink jet images. Room conditions are good for electrophotographic, pigment (carbon, carbo), dye inhibition (dye transfer), silver dye bleach, and dye/silver diffusion transfer (instant).

[e] Degradation of magnetic layer binder is a concern.

[f] Lubricant separation from binder is possible.

[g] Image change can occur if improperly processed or stored in enclosures that emit peroxides.

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

[i] Delamination is possible with some optical discs.

Annex A
(informative)

Stability of electrophotographic, dye sub, inkjet prints

Electrographic, thermal transfer dye sub diffusion and pigment-based inkjet prints have good dark stability. Dye-based inkjet prints generally also have good dark stability but will suffer from dye migration at elevated humidities and are damaged by contact with water. Ink jet prints on porous paper can be vulnerable to atmospheric pollution, particularly ozone. Prints made with other processes, such as thermal leuco-dye, can deteriorate over time and might require cold or subzero conditions for long-term preservation.

The rates of degradation and the potential for physical problems at 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.

Some current ink jet prints, especially those utilizing inks made from stable pigments or optimized dyes printed onto stable supports can have very good image stability at temperatures up to 16 °C. Where the identification of the type of ink and base cannot be determined, colder temperatures should be used.

Annex B
(informative)

Cold storage practices

The useful life of images and media can be prolonged by cold storage. All cold storage methods entail the risk of moisture condensation on the surfaces when they are brought into warmer areas where the dew point is crossed. This can be avoided by placing the media in sealed moisture proof containers or bags prior to removal from cold storage and allowing them to warm up to a temperature above the dew point. An alternate procedure is to allow the material to warm up in a conditioning chamber. It should be cautioned that when media is removed from cold storage for viewing, the beneficial effect of cold storage will be mitigated and degradation will proceed at a higher rate. Media stored in cold vaults or freezers lacking humidity control require moisture-proof enclosures for protection against humidity extremes. More details about the use and advantages of cold storage are given in ISO 18920.

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