Canadian Council of Archives
Conseil canadien des archives

Basic Conservation of Archival Materials : Revised Edition, 2003

Chapter 3 – Environment

Introduction

Favourable environmental conditions within an archives will have a profound effect on the life expectancy of every record in the collection. Factors within the environment that affect an archival collection include: relative humidity and temperature, light, pollutants and biological attack. Other factors such as pests and damage associated with water and fire are discussed in Chapter 4: Disaster Preparedness.

Achieving the optimum environmental conditions in an archives can be difficult and expensive. It is all the more important, therefore, to keep in mind that every step toward better conditions will benefit the entire collection. Make a start, however small, by upgrading the environment. Work toward eliminating the extremes. If only a certain degree is attainable at one time, don't give up. Continue making improvements as the budget permits. Each improvement will bring your archives closer to the recommended conditions.

When Requirements Vary

One of the more challenging aspects of preservation is that different records/media have different optimal environmental conditions. Ideally, records with different environmental requirements are housed in storage areas with separate, dedicated climate control systems. However, as most small and medium-sized archives lack the space and funds to provide separate relative humidity and temperature zones and as many record series contain a variety of media, compromise is inevitable. In a general collection of mixed archival materials, paper will typically form the bulk of the collection, so the guidelines for paper would therefore set the norm for this kind of collection.

Relative Humidity and Temperature

Control of both relative humidity and temperature is important because both have a profound affect on the life expectancy of the collection. A general rule is that with every 5°C increase in temperature, reaction rates double. Or to put it another way, archival records stored, for example, at 20°C rather than 15°C will have half the life expectancy. The general rule for relative humidity is that when the relative humidity is halved the life expectancy of the record is doubled. Of course, there are limits as to the practical control and desirability of greatly reduced temperatures and relative humidity to various media.

Relative humidity is defined as the amount of water vapour in a given volume of air compared as a percentage of the maximum amount of moisture the air could hold at a given temperature.

Relative humidity and temperature form an inverse relationship. When the temperature goes up, the warm air can hold more moisture, so the relative humidity drops. Conversely, when the temperature goes down, the cooler air can hold less moisture and so the relative humidity increases.

Archival collections are primarily composed of organic materials: paper, photographic media, leather (book bindings), magnetic media and parchment, and as such, are hygroscopic. Hygroscopic materials absorb and desorb moisture from the ambient environment. This means that when the relative humidity increases, the moisture content of organic materials increases resulting in expansion of the material. When the relative humidity decreases, organic materials loose moisture content and tend to shrink.

High relative humidity levels can lead to the growth of mould and mildew, increased chemical deterioration, cockling of paper and parchment, warping of books and increase the likelihood of pest infestations. Low relative humidity leads to desiccation of archival records making them brittle and susceptible to cracking, particularly when handled.

Environmental Control Standards

In the last few years the accepted relative humidity and temperature standards have been re-evaluated. Prior to this re-evaluation, it was generally accepted that minimal fluctuation of both temperature (+/−2° in 24 hours) and relative humidity (+/−3–5% in 24 hours) was considered optimum for the long-term preservation of collections. (The actual temperature and relative humidity set points vary with the specific media.) In order to maintain these set points sophisticated HVACs (heating, ventilating, air conditioning systems) are required. HVACs are costly to install and maintain, and depending on the building and HVAC design specifications, it may be difficult to achieve the desired set points consistently throughout the year. Due to these reasons environmental standards were reviewed to determine what damage would be caused by allowing wider set point fluctuations.

Chemical deterioration is accelerated with higher temperatures and to a lesser degree higher relative humidity levels. In order to re-evaluate environmental requirements for archival materials Michalski in the CCA Information Bulletin 15 – *Guidelines for Humidity and Temperature in Canadian Archives* ranks archival records based on their chemical and mechanical stability. Three categories of archival records based on their chemical stability are listed.

High Chemical Stability	**Medium Chemical Stability**	**Low Chemical Stability**
Rag paper, parchment, alkaline paper, most black and white silver gelatin photographs, etc.	Mildly acidic papers, most black and white silver gelatin photographs, etc.	Strongly acidic paper, poorly processed photographs, most colour photographs, magnetic media, etc.
*for a complete list see CCA Information Bulletin 15 – *Guidelines for Humidity and Temperature in Canadian Archives* (Michalski 2000:3)		

Michalski suggests that as most archival records come to an archives from an uncontrolled environment (an office, historic house, basement) they have already been subjected to wide fluctuations in relative humidity and temperature, so much of the mechanical damage that is caused by these fluctuations has already occurred. In following this rationale allowing a somewhat wider range of relative humidity fluctuations would not cause further mechanical damage.

Mechanical damage to archival records is ranked by comparing high, medium and low vulnerability records against +/−5, 10, 20 and 40% relative humidity fluctuations. The damage is ranked qualitatively – none/tiny; none/small damage, etc. In Table 4, "Estimated Mechanical Risks to Records," it is only at the +/−20% fluctuation level that small-severe damage is noted. However, it is noted that mechanical damage refers to irreversible deformation, fracture, and delamination. This damage is cumulative so that several thousand fluctuations of "small" can accumulate to "severe" (Michalski 2000:11).

While there is a general agreement that cooler and drier environmental conditions benefit the vast majority of archival materials, confusion arises as to which standard or guideline to follow for specific media. Currently, environmental standards for various media are set by the American National Standards Institute (ANSI), International Organization of Standards (ISO), and other standards bodies in addition to recommendations suggested by the Canadian Conservation Institute (CCI) and other large institutions and research agencies.

At the end of this chapter, a chart, "Environmental Recommendations for Archival Records" can be found where comparisons between the various standards and recommendations for most archival media are made.

It should be noted that small relative humidity fluctuations are now recognized as being of secondary concern. Of primary importance in the preservation of archival materials is providing a cool and dry storage area.

While there is general agreement that maintenance of a stable relative humidity and temperature provides the greatest life expectancy for the collection there is also the recognition that not all buildings are designed to maintain these conditions nor do most small archives have the budget to install or maintain HVAC systems.

A new system for defining environmental standards has been outlined in Chapter 20, "Museums, Libraries, and Archives" of the 1999 ASHRAE (American Society of Heating, Refrigeration and Air-Conditions Engineers) Handbook. This chapter is primarily designed for institutions considering a new building or HVAC system.

In Table 2, "Temperature and Relative Humidity Specifications for Museums, Gallery, Library and Archival Collections" five primary classes of control (AA, A, B, C, D) are described. Risks and benefits to the collection are broadly outlined for each class. The levels or class of control vary from "AA" – "precision control" at 50% +/−5% and temperature set between 15-25°C +/−2°C to "D" where preventing dampness (relative humidity below 75%) is the goal. The use of cold storage is recommended for chemically unstable library and archival materials with a recommended environment of −20°C +/−2°C and 40% relative humidity.

What is interesting to note is that is that the "AA" class of control corresponds to the traditional museum/archival environmental standards. At the "AA" level there is "no risk of mechanical damage to most artifacts" however, the life expectancy of chemically unstable records is measured in decades.

The ASHRAE temperature and relative humidity specifications takes into account the reality that not all buildings operate at, nor can they be retrofitted to, an "AA" level.

What this system attempts to do is to identify levels of risk in terms of both mechanical and chemical damage to your collection by maintaining a storage environment at a "B," "C" or "D" level in comparison to the "AA" level.

How do we interpret this re-evaluation of environmental standards and what does it mean in practical terms to small archives with a limited budget and a "one size fits all" storage environment?

1. A cooler, drier environment benefits the entire archival collection.
2. For a mixed media archival collection stored in one records storage area (high, medium and low chemical stability and variable mechanical stability) the weaker links (e.g. magnetic media) define the storage requirements. Therefore, the cooler and drier the environment the better, without going down to cold storage temperatures.

   A good compromise for a mixed collection would be 45% +/−10% relative humidity and 18 to 20°C.
3. The temperature could be lower as long as the relative humidity could still be kept at 45% relative humidity.
4. For most small archives with one or two storage rooms the use of portable humidifiers and dehumidifiers is a low cost option in creating and maintaining a relatively stable 45% +/−10% and 18 to 20°C .
5. Cold storage is the only storage method which will ensure the usability of medium to low chemical stability records such as cellulose acetate and cellulose nitrate negatives and most colour photographs.
6. Archival storage boxes can provide an effective microenvironment which minimize relative humidity fluctuations within the box, and hence the relative humidity fluctuations affecting the records stored within the box.

Cold Storage

If one preservation strategy is clear from the re-evaluation of environmental standards it is that a cooler, dryer environment benefits all collections. Cool or cold storage is particularly beneficial for many photographic collections such as deteriorating cellulose acetate negatives, cellulose nitrates and colour media.

In recent years, a relatively simple and inexpensive method of creating a cold storage environment has been developed (McCormick-Goodhart 1999). This critical moisture indicator (CMI) package uses a simple vapour proof packaging system which is housed in an upright frost-free freezer. Walk-in freezers can also be used but they are more expensive to install and maintain.

Cold storage in conjunction with an effective reformatting programme is the only successful, cost-effective strategy available for the long-term preservation of collections such as deteriorating cellulose acetate negatives. A conservator should be contacted in the planning of a cold storage system.

Macro and Microenvironment

Macroenvironment refers to the environmental conditions (relative humidity, temperature and air quality) within the record storage room. Within the macroenvironment environmental conditions can vary. These pockets of higher relative humidity/lower temperature and lower relative humidity/higher temperature are known as microenvironments. A microenvironment can also refer to the conditions inside a records storage box.

The use of protective enclosures is the most common method of providing a more stable microenvironment. Archival document boxes and sealed frames are two examples of enclosures which can provide a more stable microenvironment while providing physical protection and support. These enclosures help to buffer the records from fluctuations in room temperature and relative humidity and keep dust and pollutants out.

A microenviornment can also be created by controlling the climate in one area of the archives at optimum conditions. The most effective space would be an insulated room with its own vapour barrier and climate control system, constructed within the existing archives building.

The archives may possess an existing appropriate microclimate in some part of the building where a particular set of stable environmental conditions exist. A cooler and lower relative humidity area, for instance, could be used for storing photographic collections. To determine whether a certain area of the building has a suitable microclimate for storing collections, regular monitoring is necessary for a period of some months.

Obviously, not all microclimates are beneficial. Hot, dry furnace rooms, wet basements and damp or cold areas near exterior walls and windows hasten the deterioration of archival records. Regular air circulation throughout the room may diminish the formation of unwanted microclimates thus reducing the chance of mould outbreaks and other forms of deterioration associated with damper areas.

Humidifiers and Dehumidifiers

Humidifiers and dehumidifiers can be used to modify the relative humidity in an enclosed room. Both humidifiers and dehumidifiers should be equipped with an automatic humidistat to maintain relative humidity control.

For maximum effectiveness, place the machine in the middle of the room and make sure that the area has good air circulation. The unit should be positioned so that a leak or overflow will not endanger the collection. Humidifiers should never be located where the moist air or steam could come in direct contact with archival material. Dehumidifiers should, if possible, be hooked up to a drain so that the reservoir is emptied on a continual basis. Otherwise, the dehumidifier will have to be checked and emptied on a regular basis.

To effectively dehumidify a room the dehumidifier should be capable of one air exchange per hour. Information about the dehumidifier’s capacity should be verified before installation to ensure that the dehumidifier is large enough for the room.

Implementing an Environmental Monitoring Programme

An environmental monitoring programme is a core function of a preservation programme. A monitoring programme allows you to assess the current environment to determine what modifications should be made. Records storage rooms or areas within a room can be identified and assessed as to whether they are desirable (lower relative humidity and temperature) or not. Seasonal variation in relative humidity and temperature can be tracked and areas identified where modifications should be made.

One monitoring method which is very useful in uncontrolled environmental storage areas is to use two dataloggers simultaneously. Because of the dataloggers small size they can be used to monitor relative humidity and temperature in exhibition cases, within archival boxes, map cabinets, etc. This means that the microenvironment provided by the archival storage container can be assessed in comparison to the ambient environment (the storage room). This is particularly important in a non-controlled or fluctuating environment so that an evaluation can be made as to what is actually happening with regard to relative humidity and temperature within the container and hence to the records. Simply evaluating the storage room will not give you an accurate picture as to what is happening within the storage container.

Environmental Monitoring Equipment

Hygrothermograph

A hygrothermograph records relative humidity and temperature on a graph paper which is attached to a rotating drum or disk. Hygrothermographs monitor continuously over the predetermined reading period. Depending on the hygrothermograph model, reading periods can cover one day, one week, one month or three months. Hygrothermographs should be calibrated on a regular basis. Calibration is done using a psychrometer.

Aspirating Psychrometer

An aspirating psychrometer records relative humidity and temperature. It works on the principle that a battery driven fan blows air at a constant speed over two thermometers – a dry bulb and a wet bulb. The wet bulb thermometer is simply a thermometer which has a cotton "sock" at the bulb end which is wet with distilled or deionized water. The dry bulb thermometer is a regular thermometer without a "sock." The temperatures on the wet and dry bulb are compared and by using the relative humidity slide rule the relative humidity is determined.

Psychrometers are not continuous monitors and the readings are only accurate at the time they were taken. Because of this they are not considered appropriate for an ongoing monitoring programme. They are required to calibrate hygrothermographs.

Sling psychrometers work on the same principle as above, but rather than being battery driven, they are swung by hand which causes the air to move across the wet and dry bulb thermometers. They are not as accurate as the aspirating psychrometer and are not recommended.

Dataloggers
Dataloggers monitor relative humidity and temperature digitally. Dataloggers require software to download the relative humidity and temperature information stored digitally in the datalogger. Unlike hygrothermographs, the relative humidity and temperature data cannot be seen in real time but must be downloaded. The software can generate a variety of graphs enabling one to expand specific monitoring periods. Dataloggers can be used in conjunction with a modem to allow for off-site monitoring.

Humidity Indicator Cards
Humidity indicator cards use a moisture sensitive salt (cobalt chloride) to monitor the relative humidity levels. Humidity indicator cards have 10 small patches of fabric which change colour from pink to blue depending on the humidity levels. The relative humidity level is read in the area between the colour change from pink to blue. The cards are not very accurate but do give an idea of what the relative humidity level is. These cards can be used as humidity indicators in exhibition cases. These cards are inexpensive, but do not replace an environmental monitoring programme.

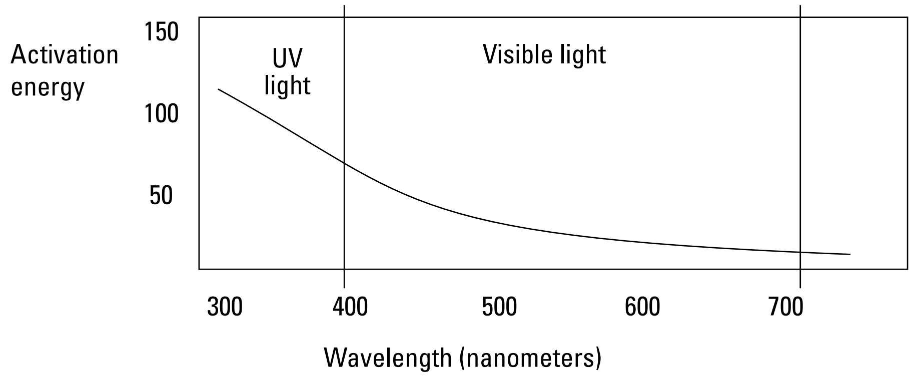
What to Do – Low Cost Solutions

- Implement an environmental monitoring programme to assess the current environment; determine whether you have any cooler, dryer areas that could be used for storing photographic materials and other media that require a lower relative humidity and temperature
- Avoid basements and attics for storage
- Add weather stripping around doors and windows to stop air leaks in winter and summer
- Install an air-conditioning unit if summertime temperatures exceed 25°C in the archival storage area
- Prevent water damage by good roof maintenance and prompt action in repairing leaky pipes
- Ensure proper drainage around the building
- Insulate the building to buffer exterior temperature change
- Install storm windows to moderate temperature and reduce condensation in winter
- Use humidifiers and dehumidifiers as required
- Install vapour barriers to help control humidity levels. It is very important that the installation be done correctly. If it is, the vapour barrier will limit the movement of water vapour to the exterior of the building. However, a poorly installed vapour barrier will lead to major problems with both collections and the building structure. An engineer/architect familiar with retrofitting technology should be hired if such a modification is planned.

Light

All light (ultraviolet (UV), visible and infrared) damages archival materials by fading, yellowing and structurally weakening them.

Light is measured in nanometers. UV light (300–400 nanometers) is more damaging to archival records as the shorter light wavelengths have a higher activation energy and cause the greatest amount of photochemical deterioration. Visible light (400–760 nanometers) and infrared light (760 – and above nanometers) also cause damage but to a lesser degree.



Sunlight and fluorescent lights are the two main UV light sources. Infrared radiation, from sunlight and incandescent light sources, is also a problem in that heat is generated which can create higher temperature/lower relative humidity microenvironments leading to the desiccation of records. It is important to remember that all light causes damage and that all light exposure is cumulative.

Light is monitored in terms of lux levels and UV levels. Lux units are used to quantify the overall level of illumination. Ultraviolet light is measured in terms microwatts/lumen and quantifies the amount of UV light emitted from the light source.

Common Light Sources			
	Ultraviolet light/ Require UV filters	*Possible heat gain*	*Preservation strategy*
Sunlight	Yes	Yes	Blinds, UV film on windows
Fluorescent Tubes	Yes, however tubes with no/low UV emissions are available which may not need UV filters	Only if the ballast is inside the display case	Use no/low UV emission tubes, UV filter sleeves
Incandescent	No	Yes	To reduce heat gain ensure distance from record
Tungsten Halogen	Yes	Yes	To reduce heat gain ensure distance from record, and use a UV filter

UV Filters

UV filters are available in many formats such as acrylic sheets, films, foils and as a coating. The UV absorbing lifespan of these materials varies with the filter type. Acrylic sheets may have a lifespan of up to 10 years whereas coatings and films should be checked around the five-year period. All UV filters should be checked with a UV monitor on a scheduled basis.

Light Monitoring Equipment

Lux Meter

A lux meter is used to monitor light levels. Lux is a unit used to measure the intensity of the light source – technically one lumen per square meter. A 150W incandescent bulb gives a light intensity of about 50 lux at a distance of one meter.

If a lux meter is not available, light levels can be measured using a built-in light meter on a SLR (single lens reflex) camera. Instructions on the use of a camera for this purpose are given in the Canadian Conservation Institute Note N2/5 *Using a Camera to Measure Light Levels.*

UV Meter

A UV meter is used to measure the amount of UV light being emitted from the light source. UV meters measure in units of microwatts/lumen. A reading of below 75 microwatts/lumen is considered acceptable for exhibition purposes. UV meters are expensive. If the archives does not have a regular exhibition schedule it would be more cost effective to borrow a UV light meter rather than purchase one for the occasional reading.

Provincial and territorial archival associations may have environmental monitoring equipment available for loan. The Canadian Conservation Institute runs an equipment loan programme. Environmental monitoring loan kits are available for a three week loan period. The cost of the environmental loan kit is $50.00. The borrower is responsible for all shipping and insurance costs.

What to Do – Low Cost Solutions

Storage area

- Keep all archival materials covered or boxed when not in use. This is one of the simplest and most inexpensive solutions to the problem of light
- Use blinds to eliminate sunlight
- Window glass filters UV light below 330 nm – apply UV filter film to windows to reduce UV light above 330 nm
- Select fluorescent tubes with low or no UV emissions or use UV filters on the tubes
- Selectively removing fluorescent tubes will reduce the overall light levels. “Dummy” tubes may have to be installed to ensure that the unit still works
- Turn lights off in the archives storage area when not in use – timers, motion sensors or shut-off switches can be installed to ensure that the light are off when no one is in the storage area

Exhibit area:

- Monitor exhibit area with lux and UV meters to determine light levels
- Use copies where possible in exhibitions
- No archival record should be on permanent display
- To reduce lux levels, use a dimmer switch, and reduce the bulb's wattage or move the light source further away from the object
- To reduce heat gain from the light source, ensure that lights are not located inside exhibition cases and are located well away from the object (see Chapter 4: Care – for exhibition guidelines)

Mould

Mould and mildew are problems commonly associated with archival collections stored in humid locations with poor air circulation. Mould can leave disfiguring stains on records and in severe cases render the document unreadable.

Mould spores are always present in the air and on records but require a certain relative humidity level before they are able to become active. Mould growth occurs when relative humidity levels rise above 65 – 70% for 48 hours or longer. Mould growth can occur over a wide range of temperatures – with most species growing between 4°C and 30°C. Mould uses cellulose, gelatin, sizing and starch adhesives as nutrients.

Working with mouldy records can pose health risks. Ensuring the health and safety of staff, volunteers and researchers should be your main priority. Hillary Kaplan in "Mold: A Follow-up" outlines a basic procedure for dealing with mould. (http://palimpsest.stanford.edu/byauth/kaplan/moldfu.html)

What to Do – Low Cost Solutions

- Ensure that the relative humidity remains below 65 – 70%
- Maintain some air circulation within the archival storage areas
- Inspect new acquisitions for mould prior to introducing the records to the storage area
- Check the storage area for damp microenvironments. These are often located near exterior walls and windows
- Insulate cold water pipes located in storage areas to avoid condensation
- See Chapter 5: Disaster Planning and Recovery for mould handling protocol

Pollutants

Airborne contaminants occur in the form of gases and particulates which can seriously jeopardize the preservation of archival collections. Sulfur dioxide, nitrogen dioxide and ozone are the primary sources of gaseous pollutants identified in the deterioration of archival collections. Other pollutants have also been identified including many volatile organic compounds (VOCs) such as acetic acid, formaldehyde, etc. (Tétreault 1999).

Many of the indoor pollutants are generated by storage materials, paints, untreated wood, or by the collections materials themselves.

One of the primary sources of cellulose deterioration is photo-oxidation. Sulfur dioxide and nitrogen dioxide both speed up the photo-oxidation process. High relative humidity levels also accelerate the photo-oxidation degradation.

Recommendations for Gaseous Contamination Levels			
	_g/m^3	ppb	ppb/vol
	Lull 1995:7		Wilson 1995:3
SO_2 (sulfur dioxide)	1 to 10	0.38 to 3.8	5–10
NO_2 (nitrogen oxides)	5 to 10	2.5 to 5.0	5–10
O_3 (ozone)	2 to 25	1.0 to 12.8	5–10

In the past, filtration systems were often recommended for control of gaseous pollution. More recent research suggest that molecules in gaseous pollutants are too small to be trapped by any filtering system and must be removed from the air through chemical reaction with another substance. In other words, the elimination of gaseous pollutants from indoor air requires air purification equipment. However, some degree of control can be achieved by simply dealing with the known sources: remove poor quality paper storage enclosures, seal untreated wood, make sure that paints have cured before bringing collections into that area, set up the photocopier in a separate, well ventilated area and so on.

Particulate pollutants are also a concern. Particulate pollutants include grit, smoke, dust, etc. which originate largely from industrial processes, vehicle engines, wood and coal fired heating systems. They are generally abrasive and acidic, and can be highly reactive chemically. Particulates are generally removed by air intake filters – the size of particulates removed will depend on the porosity of filtration.

Electrostatic filters are known for their effectiveness in reducing particulate pollution. Unfortunately, these air cleaners produce ozone, a powerful oxidant which accelerates deterioration of many organic materials such as cellulose and are not recommended.

Recommendations for Particulate Filtration		
	Level of filtration %	
	(Lull 1995:7)	(Wilson 1995:3)
Combined stack and user areas	Filter to remove better than 50% of 0.5 micron particles	60–80
Stack areas, users excluded except for retrieval		90–95
Optimum preservation areas		>95

Monitoring of gaseous and particulate pollutants requires specialized equipment. Monitoring should be undertaken by a trained engineer, conservator, or consultant.

What to Do – Low Cost Solutions

- Keep doors and windows closed
- Use materials known to be benign to collections
- Check and replace air filters/scrubbers on a regular basis
- Air intakes should be located in as "clean" a location as possible
- If pollutant levels are a concern, contact Environment Canada for the pollutant levels in your area

Environmental Standards Overview			
Media	**Standards or Guidelines**		**Reference**
	Temperature	**Relative Humidity**	
Paper Archival, textural, library materials, cartographic media Prints, drawings	Combined stacks and user areas 21°C max. +/−2°C Stack areas – access and retrieval only 18°C max. +/−2°C Stacks – optimum preservation 1.7°C – 18.3°C +/−2°C Storage 15.5°C – 18.3°C Occupied 15.5°C – 23.8°C	30 – 50% +/−3% 30 – 50% +/−3% 30 – 50% +/−3% 40–45% 40–45%	Wilson (1995:2) Lull (1995:7)
Photographs Black and white prints	Less than 18°C +/−2°C in 24 hr	30–50% +/−5% in 24 hr	ANSI/NAPM IT9.20-1996
Glass plate negatives	18°C +/−2°C in 24 hr	30–40% +/−5% in 24 hr	ISO 18918:2000 (ANSI/NAPM IT9.18-1996)
Black and white silver gelatin on polyester film base	21°C +/−2°C in 24 hr	20–50% +/−5% in 24 hr	ANSI/PIMA IT9.11-1998
Motion picture films	21°C	20–50% +/−5% in 24 hr	ANSI/PIMA IT9.11-1998

Media	Standards or Guidelines		Reference
	Temperature	Relative Humidity	
Deteriorating cellulose acetates/cellulose nitrate negatives and colour media *Cold storage	−18°C	35%–60%	McCormick-Goodhart 1998:20,21
Black and white silver gelatin on triacetate base	2°C 5°C 7°C	20–50% 20–40% 20–30%	ANSI/PIMA IT9.11-1998:6
Colour films (chromogenic) on triacetate and polyester film base and Diazo on triacetate and polyester film base	2°C −3°C −10°C	20–30% 20–40% 20–50%	ANSI/PIMA IT9.11-1998:6
Colour prints	less than 2°C	30–40%	ISO 18920
Microfilm masters Black and white silver gelatin on polyester base thermally processed silver Vesicular on polyester Silver dye bleach on polyester	21°C maximum	20–50%	ANSI/PIMA IT9.11-1998:6
Magnetic media on polyester base	Maximum temperatures 23°C +/−2°C in 24 hr 17°C +/−2°C in 24 hr 11°C +/−2°C in 24 hr 5°C +/−2°C	Maximum relative humidity 20% 30% 50% 50% +/−10%	ANSI/NAPM IT9.23-1998:5 (ISO 18923) Michalski 2000:19
Optical discs media	Less than 23°C Above −10°C	20%–50% +/−10%	ANSI/NAPM IT9.25-1998:3 ISO DIS 18925

The ANSI IT9 committee is no longer producing standards. The ISO international standards will take their place. The new numbering system for the IT9 group standards will be the ISO 189XX series. This means that ANSI IT 9.11 will become ISO 18911. Currently, we are in the transition period with both ANSI and ISO standards. As standards are reviewed and updated they will change to the ISO numbering system.

Suggested Readings

1999. Museums, Libraries and Archives. In *ASHRAE Applications Handbook.* Atlanta: American Society of Heating, Refrigeration and Air-Conditioning Engineers. 20.1–20.13.

ANSI/PIMA IT9.2-1998 *Photographic Processed Films, Plates, and Papers – Filing Enclosures and Storage Containers.* New York: ANSI.

ANSI/PIMA IT9.11-1998 *Processed Safety Photographic Films – Storage*. New York: ANSI.

ANSI/NAPM IT9.18-1996 *Processed Photographic Plates* – Storage Practices. New York: ANSI. ISO 18918:2000

ANSI/NAPM IT9.23-1998 *Polyester Base Magnetic Tape – Storage Practices,* New York: ANSI. ISO 18923

ANSI/PIMA IT9.25-1998 *Optical Disc Media – Storage*, New York: ANSI. ISO DIS 18925

ISO 18920. 2000. *Imaging materials – Processed photographic reflection prints – Storage Practices*, Geneva: ISO.

Canadian Conservation Institute. 1992. *Using a Camera to Measure Light Levels*. Note N2/5. Ottawa: Canadian Conservation Institute.

Lull, William, P. and P. Banks. 1995. *Conservation Environment Guidelines for Libraries and Archives.* 1995. Ottawa: Canadian Council of Archives.

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