LYRASIS

Preservation Services Leaflet

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Environmental Specifications for the Storage of Library & Archival Materials

INTRODUCTION

Books, papers, and other items in library and archival collections are made up of a variety of components. The useful life of these materials is determined by the inherent characteristics of these components and by the environment in which they are housed. Paper manufactured since the middle of the nineteenth century is highly acidic and thus subject to rapid deterioration. Strict environmental controls are necessary to slow the rate of deterioration since the useful life of documentary materials is significantly affected by the levels of temperature, relative humidity, light, and air pollution in which they are stored. Minimizing fluctuations in temperature and relative humidity is an attainable goal, and it retards chemical deterioration. Environmental conditions for documentary materials stored separately from areas used by patrons can and should be maintained at more stringent levels than for materials stored in areas used by people.

TEMPERATURE

Most of the deterioration of library and archival resources is chemical in nature, and heat speeds the rate of the chemical reactions that damages these materials. For example, in a controlled laboratory setting it has been shown that the deterioration rate of cellulose (the main component of paper) is increased 2.5 times as temperature is increased from 68 to 70 degrees Fahrenheit. Heat also encourages biological agents, such as insects and mold, and directly affects relative humidity. Organic materials do not have a high degree of thermal expansivity, or swelling due to heat, but variations in heat effect relative humidity, and fluctuations in relative humidity can cause structural damage to paper-based materials. Over time, fluctuations in temperature and relative humidity actually cause pages to separate from their bindings. Collection materials with components of animal origin such as vellum or gelatin are particularly sensitive to fluctuations in relative humidity. Fluctuations due to seasonal variations in temperature should be managed so that such changes are gradual. Rapid fluctuations do the most damage to collections. Therefore, it is recommended that repositories maintain the temperatures outlined below. If this is not possible, repositories can contribute to the longevity of their materials by maintaining constancy of temperature within the specified ranges.

Recommendations:

Materials	Temperature (Degrees F)	Allowable Range (+ Or -)
Books, Paper, & People	68-72°	5°
Books & Paper Alone	60°	5°
Photographic Materials	50°	5°
Books & Photographic Materials	60°	5°
Magnetic Media	50°	2°

RELATIVE HUMIDITY

Humidity is the amount of moisture in air at a certain temperature and pressure, expressed as a percentage of the total amount the air can hold at that temperature and pressure. In general, warmer air holds more moisture. High humidity, like high temperature, accelerates the rate of chemical reactions and increases the rate of deterioration of library and archival materials. A certain level of relative humidity is recommended for paper to retain its flexibility. Film and other photographic media require a lower level of relative humidity for optimum storage conditions.

Most collection materials are composite structures made of various components. For example, books can be constructed of paper, board, string, adhesive, cloth, and leather. The components of books and photographic materials stretch or shrink at differing rates in response to changes in their moisture content, which is directly related to the level of relative humidity in the surrounding air. Thus, book components tend to fall apart and photographic materials tend to flake or peel away from their paper supports when the relative humidity fluctuates.

The recommended level of relative humidity is a compromise among several requirements: (1) a level of moisture high enough to maintain flexibility, (2) a level low enough to slow deterioration of materials and to control insects and mold, and (3) a level which will do no structural harm to buildings due to condensation in cold weather. The important controlling factor in establishing an appropriate level of relative humidity is to maintain it within a narrow range: plus or minus 3%.

Recommendations:

Contents	Relative Humidity	**Allowable Fluctuations (+ or -)**
Books and Paper	40-50%	3%
Photographic Materials	35%	3%
Books, Papers, and Photos	50%	3%
Magnetic Media	30%	3%

Maintaining good air circulation is also important for the preservation of library and archival materials. Pockets of dead air should be eliminated, as these make the regulation of relative humidity and temperature levels more difficult and promotes the growth of biological agents, mold, and insects.

AIR POLLUTION

Both gaseous and particulate air pollutants are harmful to collections. Gases such as sulfur dioxide, hydrogen sulfide, nitrogen oxides, and ozone are absorbed from the air into the paper. These gases react with the moisture in paper and in the atmosphere to produce acids, which increase the rate of paper deterioration, break down the fiber structure of paper, and cause embrittlement. Particulate pollution is made up of dust, ash, smoke, dirt, and mold spores. Particulate pollution abrades, disfigures, and obscures text and can also increase acidity and the presence of mold spores.

Recommendations:

The most common method of safely removing gaseous pollutants uses filters of activated charcoal, or aluminum impregnated with potassium permanganate. One vendor for these products is Purafil.™ The aluminum pellets initially cost more than activated charcoal, but they last longer.

Established standards for gaseous pollutants specify levels of ten micrograms per cubic centimeter for sulfur dioxide and two micrograms per cubic centimeter for ozone. Particulate filters which produce filtering efficiencies of at least 60% are a good compromise in air systems which re-circulate 90% of the air. Very high efficiency filters such as HEPA filters are best suited to small, closed areas. These filters are generally too costly in price, energy consumed, and maintenance for use throughout library and archive buildings. Electrostatic filtering is not recommended, because electrostatic precipitators off-gas the pollutant ozone into the air as they filter particulate matter.

LIGHT

All wavelengths of light are damaging to library and archival materials. Ultraviolet light, which is light at wavelengths less than 400 nanometers, cannot be seen by the naked eye and causes the most damage. Sunlight has the highest proportion of UV radiation, followed by fluorescent and incandescent lighting. Light causes bindings, inks, and dyes to fade; darkens and yellows paper; and weakens cellulosic fibers through bleaching and oxidation.

The damage caused by light is dependent upon the intensity, the type of light, and the duration of exposure. Light damage is cumulative. Exposure levels are monitored by calculating total exposure, which is the product of the intensity of the source multiplied by the length of exposure. For example, 10 hours of light exposure at the intensity of 5 footcandles (fc) equals 2 hours at 25 fc intensity; both total 50 fc Hours.

Recommendations:

Type of Space	*Light Level Range*
Storage	10-50 lux (1-5 fc)
Display	50-150 lux (5-15 fc)
Reading/work areas	300-600 lux (30-60)*

*Short exposures are recommended for paper, photographs, and other light sensitive materials.

All light is damaging, so lights should be turned off as much as possible in the stacks. In a situation where study carrels or desks are located in the stacks, carrels should be illuminated by individual lamps. The stack ranges should have timer switches or, at least, switches with signs that remind people to turn off the lights when they are not needed.

Ultraviolet radiation should not exceed 75 microwatts per lumen and can be minimized by using incandescent lamps or fluorescent lamps that emit low levels of UV light. UV light can also be controlled by using UV shielding or filters over fluorescent tubes and windows. Using fixed window blinds or other forms of indirect lighting will also help to reduce damage from ultraviolet radiation.

Direct sunlight and skylights should be avoided since they emit so much UV radiation. Daylight contains different kinds of light. Light from the sky (blue light) is higher in UV than light from the sun (yellow light). Reflected daylight is lower in UV than direct daylight since no surface, except snow, reflects UV. Thus, UV is most intense when it comes straight downward from a light source.

Fluorescent illumination in direct contact with collection materials should be filtered. The preferred way to filter fluorescent tubes is by using plastic coverings on the light fixtures. Covers, lenses, or glazing should be made of UV-filtering acrylic or polycarbonate. An alternative to plastic glazing is to fit each fluorescent tube with an UV-filtering sleeve, especially the ends where UV emissions are the highest. A drawback to using sleeves is that they may be lost or thrown out when tubes are changed. There are low UV emission tubes or bulbs available, but these are more expensive and hard to distinguish from regular tubes. Facilities staff could replace low emission tubes with the regular tubes without notice. Avoid fluorescent lighting in exhibit cases. Ideally, filters will prevent all UV radiation, 400 nanometers and below. Unfiltered fluorescent tubes can be used in libraries and archives if they are part of an indirect lighting system or when the collections are housed in protective boxes and enclosures.

UV radiation can be reduced by reflection as well as by filtration. Window light should be directed away from books by blinds. The blinds should be set and locked in position so they cannot be opened. Indirect light is always lower in UV because UV does not reflect. White paints containing titanium or zinc absorb UV radiation. So, if light is directed at titanium white painted ceilings and walls, the reflected illumination will have less UV content than the

original source. Exact figures about the amount of UV absorbed are lacking, so using these paints should supplement, not replace, other filtering efforts.

The major environmental factors that affect the longevity of library and archive collections are temperature, relative humidity, air quality and light. Following the recommendations outlined above is the most cost-effective way to extend the useful life of your collections. Begin by establishing an environmental monitoring program at your institution to track current conditions and to gather data to justify system upgrades.

For information on vendors who sell monitoring equipment, see Lyrasis' Environmental Control Services and Supplies informational leaflet on the Preservation Services website, <http://www.lyrasis.org/Preservation/Search%20For%20Vendors.aspx>.

There are a few quick and easy interim ways to improve the environment. Start by practicing good housekeeping. Periodically cleaning the stacks will cut down on particulate pollution. Make sure the heating, ventilating and air conditioning system is functioning properly and is regularly maintained. Turn off interior lights when they are not in use. Close window blinds to eliminate unnecessary UV radiation and keep them closed. Eliminate damp areas using portable dehumidifiers. Use fans to improve circulation in 'dead air' spaces.

The Image Permanence Institute (IPI) at the Rochester Institute of Technology developed a new preservation software tool, the Preservation Calculator. This program allows you to plug in temperature and humidity levels to compute a Preservation Index, the estimated lifespan of your collection materials in years. It also predicts the number of days until mold germination and estimates the aging rate; slow, moderate, fast, or very fast. The freeware may be downloaded from the IPI website, <http://www.imagepermanenceinstitute.org/shtml_sub/dl_prescalc.asp>.

For further reading:

Appelbaum, Barbara. ***Guide to Environmental Protection of Collections***. Madison: Sound View Press, 1991.

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

Ogden, Sherelyn, ed. **"Temperature, Relative Humidity, Light and Air Quality: Basic Guidelines for Preservation**," in *Preservation of Library & Archival Materials: A Manual*. 3rd ed. Andover: Northeast Document Conservation Center, 1999

Thomson, Gary. ***The Museum Environment***. 2nd ed. London: Butterworths, 1986.