Canadian Council of Archives
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Basic Conservation of Archival Materials : Revised Edition, 2003

Chapter 6 – Collections

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Introduction

Control and maintenance of a stable environment (relative humidity and temperature) and careful handling practices will significantly prolong the lifespan of a collection. The selection of appropriate archival storage enclosure will also help to increase the life expectancy of the record.

This chapter outlines recommended storage environments, storage enclosures and specific handling guidelines for the following media:

- Paper
  - Textual records
  - Oversized materials
  - Books
  - Newspapers
- Parchment and vellum
- Photographic media
  - Black and white – negatives and prints
  - Colour media
  - Motion picture film
  - Microfilm
- Machine readable records
  - Phonographic sound recordings
  - Magnetic media
  - Digital media
- Documentary art

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.

Enclosures

Enclosures should provide protection from dust, mishandling and pollutants. They should also provide physical support. Most archival enclosures are made from either paper or plastic. The choice of using either paper or plastic will depend on the type of record being enclosed and on the archives environmental conditions.

Paper Enclosures

Poor quality acidic enclosures may transfer acids to the enclosed record causing embrittlement, discolouration and may increase the rate of deterioration.

All archival paper enclosures should be made from:

- Acid-free materials
- Fully bleached, alpha cellulose (highly processed wood pulp) or rag (cotton or linen) pulp
- Free of lignin and ground wood
- Paper with a pH between 7 and 8.5 with an alkaline reserve of 2% calcium carbonate or other suitable alkaline buffer
- Paper that is alkaline or neutral sized

Paper enclosures selected for photographic enclosures must meet the above recommendations in addition to passing the Photographic Activity Test (ANSI/NAPM IT9.16-1993 /ISO 14523:1997)

pH

pH (potential Hydrogen) is a measurement which determines acidity or alkalinity. pH is measured on a scale from 0 to 14. pH 7 is neutral; below pH 7 is acidic and above pH 7 is alkaline. The pH scale is logarithmic which means that pH 5 is 10 times more acidic that pH 6 and pH 4 is 100 times more acidic that pH 6. A buffered paper is a paper with a pH above 7. A pH neutral paper has a pH of 7 and an acidic paper has a pH below 7.

Molecular Traps

Some archival enclosures, in addition to alkaline buffering have molecular traps. Molecular traps, made from either zeolites or activated carbon, are designed to adsorb specific types of gaseous pollutants. It is thought that the molecular trap will trap or adsorb pollutants from the ambient environment or pollutants being off-gassed by the archival record. These types of enclosures could be particularly useful for archives with poor environmental control and/or high indoor pollutant levels.

Plastics

A wide variety of plastic enclosures are available. Plastic enclosures selected for archival use should not contain plasticizers, slip agents, ultraviolet inhibitors, dyes, coatings or other materials that can break down leading to the deterioration of the enclosed record.

Safe plastics include:

- Polyester (polyethylene terepthalate) Mylar Type D or Milinex 516
- Polypropylene
- Polyethylene – high density
- Polystyrene
- Polycarbonate

Avoid polyvinyl chloride (PVC) plastic. The Beilstein Test (CCI Note N17/1) is simple method to determine if a plastic contains chlorine. It does not specifically identify PVC but if the test is positive, indicating that chlorine is present, the plastic would not be an appropriate archival storage material.

Paper Records

Paper records are found in a myriad of formats in archival collections. Paper forms the base for most textual documents, many types of architectural reproductions, books, photographic prints and even early audio recordings to name a few.

The composition of paper plays a key role in its longevity. European paper made prior to the mid 19th century, known as rag paper, was made primarily from cotton and linen fibres. Rag paper tends to be chemically stable with a neutral pH and a life expectancy of several hundred years. Paper made after the mid 19th century is often made from wood pulp fibre and has inherent instability problems from the lignin and hemicellulose left in the semi-processed papers. Newsprint is an example of a minimally processed wood pulp paper. Since the mid 1980s a wide variety of alkaline processed wood pulp papers have been available which meet archival standards in that the lignin, hemicellulose and other undesired byproducts have been removed. In fact, most of the "archival" paper enclosures found in conservation supply catalogues are made from a highly processed wood pulp paper.

One way to take advantage of the availability of alkaline processed papers which meet ANSI Z39.48-1992 (R1997) *Permanence of Paper for Publications and Documents in Libraries and Archives* and the new Canadian standard CGSB-9.70-2000 *Permanence of Paper for Records, Books and Other Documents* is to produce record series which are designated archival from the point of creation on a paper which meets this standard. This will greatly increase their potential life expectancy and, hopefully, minimize preservation costs in the future.

Paper records, whether made from a rag paper or a poorly processed wood pulp paper, benefit from being housed in good quality enclosures.

	Storage Environment		Storage Enclosures
	Relative Humidity	**Temperature**	
Paper Records	Recommended 40–45% if possible Acceptable 30–50% +/–3% daily fluctuation	18 C +/–2° cooler	**Documents** – acid-free, buffered file folders Fill no more than 1/2" thick **Folders** – should be stored in archival document boxes **Archival document boxes** – acid-free buffered board or Coroplast (polyethylene/polypropylene copolymer) **Polyester encapsulation**
Oversize Records Architectural Drawings Maps			**Map folders** – acid-free, buffered map folders Unbuffered enclosures for blueprints, diazo Fill no more than 1/2" thick **Polyester encapsulation**
Books Scrapbooks			**Acid-free drop spine boxes, clam shell boxes, phase boxes, book wrappers** boxes are available commercially although custom made boxes may be required
Newspaper			**Microfilm** and maintain microfilm master as outlined on page 62. **Buffered drop-front boxes**

Storage and Handling

Enclosures for Unbound Flat Paper Records

- Store in acid-free, buffered file folders filled no more than 1/2" thick.
- The file folders should be housed in archival document boxes. All file folders should be the same size. The box should be full, with folders fitting snugly within it to prevent sagging, but not so tightly packed that the records are damaged. If the folders do not fill the archival document box, the unused area should be filled with acid free tissue, ethafoam block or other safe archival material.
- Boxes should be stored on shelves that support the entire box.
- When retrieving a small format record, remove the entire file folder from the document box rather than trying to extract the item from the folder while it is in the box.
- Have two people carry large boxes and lift large flat items off shelves or out of map cabinets.

- Mounting boards can become brittle with age. Support a mounted record adequately to ensure that the board does not break, causing the record to tear or fall to the floor.
- Do not roll varnished maps. If they are already rolled and are very brittle, handle them as little as possible.
- If a record is folded, unfold it and store it flat if possible. Repeated folding and unfolding will cause breaking or tearing along the folds.

Oversize Storage

- Oversized records, such as architectural drawings, maps and plans, etc., should be stored horizontally in labeled acid-free map folders.
- Acid-free interleaving tissue should be used between coloured records such as architectural presentation drawings and other particularly valuable records.
- Blueprints should be stored in unbuffered enclosures as they are alkaline sensitive.
- Folders should be selected to fit the size of the drawers. All folders within one drawer should be the same size regardless of the size range of the enclosed records. This minimizes the chance that smaller folders will get pushed to the back of drawer and crushed.
- Map cabinets with shallow drawers are best for this type of storage. As a less expensive alternative, use wide, closely spaced shelves of sufficient depth so that stored items do not project beyond the front edge.
- Oversized records may have to be rolled. Overall support can be given to an oversized record by rolling it around the outside of an acid-free tube or an ABS (acrylonitrile/butadiene/styrene) plumber's pipe. ABS tube is widely available in hardware stores and generally comes in black. Do not store rolled records inside tubes as it can be difficult to remove them. The rolled record should be covered with either buffered paper or polyester film to protect the record from soiling and abrasion.

Newsprint

- Most newspapers are produced on acidic paper. As newspapers are valued for their informational content rather than for their artifactual value, photo-copying and microfilming are cost-effective preservation options. If you are photocopying newspapers use a "permanent" paper that meets the standards outlined in *Permanence of Paper for Publications and Documents in Libraries and Archives* ANSI Z39.48-1992 (R1997) or the Canadian standard CGSB-9.70-2000 *Permanence of Paper for Records, Books and Other Documents.*
- Newspaper clippings and inserts should be removed and photocopied if interspersed with textual documents. The newspaper clipping photocopy should replace the original in the file.

Books

- Most books will not require enclosures, however, books which are fragile, damaged or valuable may require enclosures. Phase boxes, book wrappers, drop-front or clam shell boxes can be used to enclose books. Slipcases can cause abrasion and so should be avoided.
- Vellum bound books should also be boxed as vellum reacts quickly to changes in relative humidity and temperature which can result in warping of the boards.
- Make sure that shelves are of a width and height that will accommodate all the books. Books should not project beyond the edge of a shelf. Designate special areas for oversized books.
- Store oversized books on their side on a shelf which is large enough to fully support the book. Do not store more than two or three books on top of one another.
- Books are not designed to stand on a shelf without support. Use sturdy, non-slip book ends which are large enough to provide adequate support.
- If a book will not fit on the shelf in an upright position, shelve it spine down rather than spine up to avoid placing stress on the hinges. Horizontal storage is a better alternative.
- Miniature books should be shelved separately or stored in protective boxes.
- To remove a book from its shelf, push in the books on either side, then remove the one you want by grasping it on either side of the cover near the spine. Never remove a book by pulling the top of the spine with your fingers.
- When opening a book, support it with your hands. If the book does not open readily or lie flat when it is opened, don't force it.
- Use a book cradle for research and when placing a book on display.
- If a book cover is loose or detached, tie it in place with linen or cotton tape. Place the knot along the fore edge or top of the textblock. Store the book in a box if possible.
- Never use elastic bands to hold a book together as they will cut into the book and leave a sticky mess as they deteriorate.
- Never use pressure sensitive adhesive tape to reattach covers or repair torn pages.

Scrapbooks

- Most scrapbooks can be stored following the guidelines outlined for books.
- Interleave scrapbook pages where necessary with acid-free buffered tissue. This reduces transfer of acids, staining or other unstable material being transferred from one page to another. Interleaving should be used to separate newspaper clippings from adjacent pages without newspaper clipping,

photographs from acidic pages etc. Interleaving can cause the textblock to swell which can place excess strain on the spine. If the scrapbook is tightly bound interleave sparingly, if the scrapbook is loosely bound interleave where required.

- Every effort should be made to retain the original format of the scrapbook
- If the scrapbook is to be taken apart, the original order of the book must be documented by photocopying, photography, or microfilming.

Parchment and Vellum

Parchment and vellum records are made from animal skins which have been treated with lime, scraped, stretched and burnished. Parchment and vellum are hygroscopic materials which means that they are very susceptible to changes in relative humidity. Fluctuations in relative humidity can result in cockling and other surface deformations. This can make it a challenge to keep the record flat. Movement of the parchment and vellum can cause additional problems as these records often have seals attached to them. Seals are commonly made from wax but can also be made from shellac, applied paper or other materials. Seals do not respond to changes in relative humidity in the same way that the parchment and vellum do resulting in dimensional stress in the areas where the seal is affixed.

	Storage Environment		Storage Enclosures
	Relative Humidity	**Temperature**	
Parchment Vellum	Recommended 45–55%	18°C +/−2° cooler if possible	Acid-free buffered board enclosures are recommend over plastic enclosures as the acid-free buffered board provides a better microenvironment as it absorbs moisture whereas the plastic materials do not.

Storage and Handling

- As parchment and vellum are hygroscopic one of the primary functions of their storage enclosure, in addition to providing safe handling and support, should be to provide a microclimate which buffers against fluctuations in relative humidity. Acid-free buffered board enclosures are recommend over plastic enclosures. The acid-free buffered board provides a better micro-environment as it absorbs moisture whereas the plastic materials do not.
- Encapsulation is not recommended for parchment or vellum. Inks and other media do not penetrate the skin but sit on the surface making them more susceptible to lifting due to polyester's static charge.
- Pendant seals must be adequately supported and not allowed to dangle freely from the record.

Photographic Media

Photographic archival collections are found in a vast array of media and formats: cased photographs, black and white prints and negatives, motion picture film, colour slides, negatives, prints and transparencies to name just a few.

Photographic collections pose a range of preservation challenges ranging from the basics of rehousing collections in archival enclosures, to dealing with the failure of cellulose acetate film base, to providing cold storage for colour media, and deteriorating cellulose acetate and cellulose nitrate negatives.

Photographic Negatives

Photographic negatives have been made on a range of support media including glass plates and plastic film bases such as cellulose nitrate, cellulose acetate and polyester.

Glass Plates

Glass plate negatives can be found in archives and date from the mid 1850s through to the early 1920s. Glass plates are fragile and require extra care during handling.

Cellulose Nitrate Base Film

Cellulose nitrate was introduced commercially in 1889 as a base for negatives and film and was in use until the early 1950s. Cellulose nitrate was the only plastic film base available until the early 1920s when cellulose acetate was introduced.

Cellulose nitrate negative deterioration rates are unpredictable. Some negatives show recognizable deterioration while other negatives of the same age show few signs of deterioration. Factors which influence the rate of deterioration include the composition of the cellulose nitrate film, when it was manufactured and the storage temperature and relative humidity.

As cellulose nitrate negatives degrade they off-gas a range of deterioration byproducts which in turn increase the rate of deterioration of the off-gassing negatives and surround negatives. The deterioration of cellulose nitrate is characterized by the following five stages:

1. Amber discolouration of the film base.
2. The film becomes sticky.
3. Embrittlement and the formation of gas bubbles on the surface.
4. Film softens and exhibits a viscous frothiness.
5. Films degrades to a brown acrid powder.

Cellulose nitrate is a recognized fire hazard. As cellulose nitrate deteriorates its flash point drops dramatically. The reduced flash point in conjunction with a build-up of off-gassing byproducts in a film canister can lead to spontaneous combustion of the cellulose nitrate film. However, this does not appear to be a concern for most cellulose nitrate negative collections as the negatives are not generally housed in sealed containers.

Cellulose Nitrate Preservation Plan

1. All cellulose nitrate negatives should be identified and their condition assessed based on the five stages of deterioration outlined above.

   Negatives are generally identified by their edge printing, notch codes, date and context. If these non-destructive tests do not identify the negative, destructive testing may be used. Destructive tests include the burn test and the diphenylamine test. *Conserv O Gram* 14/9 Identification of Film Base Photographic Materials

   (www.cr.nps.gov/museum/publications/conserveogram/14-09.pdf) is a very useful guide to use when identifying film bases.

2. Isolate cellulose nitrate negatives and store them separately away from other collections.

3. Reformat negatives based on condition. The NEDCC publication "Duplication of Historic Negatives," gives a useful overview of duplication options. (www.nedcc.org/plam3/tleaf53.htm)

4. Rehouse negatives in buffered paper envelopes that have passed the Photographic Activity Test. Ideally, cellulose nitrate negatives should be placed in cold storage. Original cellulose nitrate negatives should, where possible, be retained even if duplicate negatives have been made.

Cellulose Acetate Base Film

Cellulose acetate film base, introduced in the early 1920s, was the second commercially available plastic used for photographic negatives. Cellulose acetate was also known as "safety film" as it was considered to be safer than cellulose nitrate. The term "cellulose acetate" refers to a group of acetates which includes cellulose diacetate, cellulose acetate butyrate, cellulose acetate propionate and cellulose triacetate. All of these cellulose acetates deteriorate in a similar fashion and have the same storage and handling requirements.

Cellulose acetate film base is prone to what is termed "vinegar syndrome" which refers to the acetic acid smell produced by deteriorating cellulose acetate film base. This results in a film base that shrinks, becomes embrittled, cockles and ultimately leads to emulsion loss. The causal factors leading to vinegar syndrome are high temperature, high relative humidity and off-gassing acid build up.

The deterioration of cellulose acetate film base is characterized by the following six stages (Horvath 1987):

1. No deterioration; flat negative

2. Negative exhibits slight or moderate edge curl. Edge curl is always symmetrical on the two or four sides affected

3. Smell; the negative smells distinctly of acetic acid or butyric acid. (This determination is difficult to make if there are large numbers of degraded negatives in a confined area such as a box or drawer where the acid odor permeates.)

4. Warpage is visible in the negative
5. Bubbles will be visible throughout the negative
6. Separation of the emulsion, base and anti-curl layers

Cellulose Acetate Preservation Plan

1. Identify cellulose acetate negatives.
2. As with cellulose nitrate film base cellulose acetate negatives are generally identified by their edge printing, notch codes, date and context. If these non-destructive tests do not identify the negative destructive testing may be used. Destructive tests including the burn test. *Conserv O Gram* 14/9 Identification of Film Base Photographic Materials (www.cr.nps.gov/museum/publications/conserveogram/14-09.pdf) is a very useful guide to follow when identifying film bases.
3. Assess condition of the film base.
4. The Image Permanence Institute (see Chapter 7: Where to Go For Help for contact information) has developed A-D Strips (Acid-Detecting) as a way to evaluate the stage of cellulose acetate film base deterioration.
5. Reformat negatives based on their condition.
6. Rehouse negatives in buffered paper envelopes that have passed the PAT. Ideally, cellulose acetate negatives should be placed in cold storage. Original cellulose acetate negatives should, where possible, be retained even if duplicate negatives have been made.

Polyester Base Film

Polyester based films were introduced in the mid 1950s. Polyester is superior to both cellulose nitrate and cellulose acetate as it is more stable and has a far longer life expectancy. Polyester should be used for all film duplication.

Motion picture film has been made on cellulose nitrate, cellulose acetate and polyester. Cellulose nitrate was in use from the late 1880s until the early 1950s as a 35mm motion picture film base. Cellulose nitrate was never used to make 16mm or 8mm. After 1951, 35mm motion picture film was made using cellulose triacetate.

Brief Chronology of Film Bases	
1889	Eastman Kodak – first cellulose nitrate roll film
1913	Nitrate sheet film produced
1923	First cellulose acetate film produced (16mm motion picture film only)
mid-1930s	Other manufacturers (Agfa, Defender, DuPont Defender, Hammer) produced cellulose acetate films
ca. 1940	Kodak stopped producing cellulose diacetate; produced other cellulose esters (cellulose acetate butyrate, cellulose acetate propionate)
	Cellulose nitrate film packs were in use until the mid-1940s
1947	Cellulose triacetate first produced
1950	Kodak stopped production of nitrate roll film in the U.S.
1951	Nitrate motion picture film discontinued by Kodak in U.S. (this film was frequently used by photographers for making still photos)
1955	First polyester film manufactured by DuPont

Colour Photographic Media

A wide variety of colour photographic media are found in archival collections in formats such as slides, negatives, prints and transparencies. All colour photographic processes are prone to some type of image fading. Some processes are dark fading and some are light fading. (This means that some types of colour photographs that are stored in your archives in archival document boxes are fading as you read this.) Archival storage of colour prints and film means cold storage. Temperature is the most important factor to control to minimize fading of colour photographs. Relative humidity is of secondary importance.

Cold Storage

Cool or cold storage is particularly beneficial for many photographic collections such as deteriorating cellulose acetate negatives, cellulose nitrates and colour photographic 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 stage of a cold storage system.

Microfilm

Microfilm is used to record archival materials photographically. Microfilms in archival collections can be found on cellulose nitrate, cellulose acetate and polyester film bases. Archival microfilm is usually found in a 16 or 35mm format. Archival microfilming generates three film copies:

- Master negative (silver halide on a polyester film base according to the standards outlined in ANSI MS23-1998). The master negative should not be used and should be stored in the best environment possible.
- Duplicate negative are usually a silver halide. The duplicate negative is used to make use copies.
- Use copies can be made from any of a range of formats and film base types such as diazo and vesicular.

The RLG Archives Microfilming Manual offers a thorough overview of the microfilming process and preservation issues.

	Storage Environment		Storage Enclosure
	Relative Humidity	**Temperature**	All types of photographic enclosures must pass the Photographic Activity Test ANSI IT9.16 1993 Buffered paper enclosures No plastic Cold storage
Cellulose nitrate Cellulose acetate	35–60%	−18°C	
Cellulose triacetate	20–50% 20–40% 20–30%	2°C 5°C 7°C	Buffered paper enclosures All "safe" plastic enclosure
Polyester	20–50% +/− 5% in 24 hr	21°C +/−2°C in 24 hr	Buffered paper enclosures All "safe" plastic enclosures
Glass plate negatives	30–40% +/−5% in 24 hr	18°C +/−2°C	4 flap paper enclosure
Black and white prints			
Colour film Colour prints New media – Thermal wax transfer, dye sublimination, electrophotographic colour and ink jet	20–30% 20–40% 20–50% 30–40% 30–50%	2°C −3°C −10°C less than 2°C −3°C	Buffered paper enclosures All "safe" archival plastics Cold storage
Motion picture film	20–50%	21°C	Polypropylene plastic or metal canisters
Microfilm	20–30% 20–40% 20–50%	21°C 15°C 10°C	Buffered card boxes All "safe" archival plastics

Enclosures

All enclosures for photographic media must meet the following criteria:

- *Photographic Activity Test* (PAT) (ANSI/NAPM IT9.16-1993 /ISO 14523:1997)
- *Photographic Processed Films, Plates, and Papers – Filing Enclosures and Storage Containers* (ANSI/PIMA IT9.2-1998).
- Black and white photographic materials should be stored in buffered envelopes. The acceptable pH ranges from 7–9.5.
- Colour or processed diazo photographic materials should be stored in buffered envelopes. The acceptable pH should not exceed 8.

Over the years, there has been ongoing research as to whether photographic materials should be stored in buffered or unbuffered paper enclosures. The current practice outlined in ANSI IT 9.2-1998 is that all photographic media can be housed in buffered enclosures. The only exceptions are cyanotypes which should be stored in unbuffered envelopes. (Cyanotypes are an early type of photographic print and easily identified as they are blue.)

Storage and Handling

- Wear clean, lint-free cotton gloves. Hold negative film, prints, slides and transparencies by the edges.
- Place negative or print into paper enclosures with the emulsion (dull, matte) side away from the adhesive seam.
- Avoid glassine paper envelopes.
- Ideally, each photographic print and negative should be housed in its own enclosure.

Cased Photographs

- Keep cased photographs in their original cases. Wrap the cases in acid-free tissue and then place them in a small document box or a custom-made box. If the case is missing, wrap the photograph in tissue and store it in an individual custom-made box.
- Cased photographs should be labeled on the protective box rather than on the case itself.

Glass Plate Negatives

- Store glass plate negatives vertically in four flap enclosures that have passed the PAT.
- Glass plate storage boxes should be labeled with "Glass – Fragile – Heavy."
- Broken glass plate negatives should be stored horizontally in a sink mat.
  - All sink mats should be cut to a standard exterior size designed to fit into a commercially available drop front document/photograph storage box with metal stays.
  - Insert shims (cut from the mat board off cuts) should be placed between the pieces of glass plate. This ensures that the glass plate pieces do not shift in the sink mat.
  - Attach the shims with doubled-sided 3M 451 adhesive tape.

Photographic Prints – Black and White and Colour

- Handle prints by the edge. Old prints can be brittle and cannot withstand bumps, flexing or even sharp pressure from fingers so ensure that the print is supported overall during handling.

- Rolled prints, such as panorama prints, are best stored flat. If they are brittle or difficult to unroll leave them rolled. Store them in a box separately from flat prints, until it is possible to have a conservator unroll them.
- If more than one print is housed in an envelope, ensure they are placed so that the image side of one print is housed adjacent the back of the next print – never image side to image side.
- Label the folder or protective enclosure rather than the original wherever possible. If it is absolutely essential to label a print directly, use a soft pencil (2B or 3B) very lightly on the verso.

Motion Picture Film

- Store films in polypropylene plastic canisters or in metal canisters that are clean, rust-free, unwarped and without dents.
- Store film on reels or cores that are in good condition. Storage on cores is preferable.
- Store film with a good, even, flat wind to prevent damage.
- Store film canisters vertically except for heavy reels which should be stored flat.
- If the film is an original or a master copy, it should not be projected. Copies should be made for preservation purposes and only the copies should be projected.

Microfilm

- Master negatives should be stored on an "archival" plastic reel, secured with an acid-free button tie wrapper or plastic grip clip and trailer holder. Do not use elastic bands.
- Store microfilm masters and duplicate copies in "archival" plastic or acid-free buffered card box that pass the PAT.
- Microfiche should be stored in individual acid-free buffered enclosures that pass the PAT.

Machine Readable Records

Phonographic Recordings

The term "phonographic recordings" refers to both cylinder and disc sound recordings. The first sound recording was made in 1877. Since that time the recording industry has seen the short-lived use of many materials and formats for recordings. The formats listed below represent only the most common formats used for sound recordings.

Cylinder recordings, first introduced in 1885, have been made from wax-coated cardboard and solid wax. Disc recordings which were introduced in 1887 have been made from a variety of materials such as shellac, rubber, vinyl (polyvinyl chloride) and laminated

discs. Shellac discs are composite materials made from fillers such as limestone, pigments, lubricants, binders and modifiers. Laminated discs contain a kraft paper core coated with a shellac material and are noted for problems associated with core stability.

"Instantaneous recordings" also called "acetates" were introduced in the 1930s and were in use through the 1940s. They are usually a 78 rpm format and made with a core of aluminum (or, to a lesser degree from glass or cardboard) coated with acetate or nitrate. The acetate or nitrate surface is very soft which means that they could only be played back a few times before there was noticeable deterioration. Additionally, internal decomposition causes them to become brittle and liable to crumble. The surface layer may peel away from the backings, or oil may appear on the surface as a greasy film. If your archives has instantaneous recording they should be given priority for reformatting.

Long playing (LP) discs at 33 rpm were introduced commercially in the 1940s. Most LPs are made from vinyl. The vinyl is a polyvinyl chloride composite with plasticizers, fillers, stabilizers, pigments etc. 45 rpm singles or "extended play" were introduced in 1950 and are made from a vinyl composite and later from polystyrene.

	Storage Environment		Storage Enclosure
	Relative Humidity	**Temperature**	
Discs and Cylinders	18°C max.	35–45% +/−5% max. daily	Acid-free "record"enclosures Acid-free cylinder boxes Polyethylene inner sleeves for discs

Storage and Handling

- Store all discs and cylinders vertically. Discs will warp if not stored correctly. They should be placed upright on shelves fitted with vertical partitions four inches apart. Each compartment should be loosely filled so that discs can be readily removed, yet contain enough discs to prevent them from leaning to the extent that warping will occur.
- Discs should be stored in polyethylene liners, then stored inside their original covers unless the cover is too damaged to provide adequate protection.
- Cylinders should be stored on end in acid-free boxes.
- Wear clean lintless cotton gloves when handling discs or cylinders.
- Handle discs by edges and label areas. Do not touch the playing surface.
- Remove the disc by removing both the inner disc sleeve and the disc at the same time. Do not pull the disc out by itself.
- Cylinders should be handled by inserting your fingers in the open end. Do not touch the playing surface.
- Always dust discs before and after playing. Check to make sure the turntable and stylus are clean before playing.

Magnetic Media

Magnetic media such as audio and videotape and computer floppy disks and tapes are all machine readable records and all share a similar structure. Each is composed of a base layer, a binder layer and magnetic particles that are held within the binder.

Depending on the age of the tape, the base could be composed of either cellulose acetate which was in use from the early 1930s to the 1960s or from polyester (Mylar) which was introduced in the 1960s. Cellulose acetate bases are prone to dimensional instability due to base stretching in warm and/or humid environments. Cellulose acetate is also prone to vinegar syndrome. Vinegar syndrome is characterized by the off-gassing of acetic acid (vinegar smell) which results in base shrinkage and deformation. Polyester bases are much more dimensionally stable than cellulose acetates and have a much longer life expectancy.

Magnetic media are machine readable records and as such is it important to maintain both the record and the playback equipment. Conversely, as magnetic media have a life expectancy of 10–30 years, developing and efficient copying and/or migration programme is critical to the retention of the informational content of these records.

	Storage Environment		**Storage Enclosure**
	Relative Humidity (Maximum)	**Temperature (Maximum)**	
Magnetic Media/ Polyester Base	20% 30% 50%	23°C +/−2°C in 24 hr 17°C +/−2°C in 24 hr 11°C +/−2°C in 24 hr	Acid-free card enclosures All "safe" plastic containers CD enclosures usually made from polypropylene, polystyrene
Optical Disc Media	20–50% +/−10%	Less than 23°C Above –10°C	

Storage and Handling

- Enclosures for magnetic media can include acid-free card enclosures and all "safe" archival plastics. Store cassettes, videotapes, discs and reel-to-reel tapes vertically. The reels should be supported by the hub.
- Store, play and copy all magnetic media in a clean environment.
- Use clean, lint-free gloves when handling magnetic media.
- Use clean equipment to play or copy records.
- Handle carefully so that the record is not scratched, creased or in other ways damaged.
- Use copies for researcher's use. Master copies should be remain in storage.
- Store tapes tails out (in "as played" condition). Tapes should be rewound before playing.

- Rewinding of tapes every three years is recommended to maintain a low wind tension on the tape and to keep the tape edges from touching the spool. Others believe that this starts the retensioning process to begin again and so recommend that the tapes only be rewound before playing.
- Do not touch the playing surface.
- Do not drop magnetic media.
- Keep magnetic media away from strong magnetic fields.

Optical Disc Media

Compact Discs

Simply put, compact discs are laminate structures with a core, reflective layer and a lacquer layer. The core is usually a polycarbonate plastic but can also be metal or etched glass. The reflective layer is usually aluminum but is occasionally gold. The lacquer layer is added for protection in handling and use.

There are many types of CDs. Each CD format can vary in laminate components and vary in how the information is recorded.

- Compact disc digital audio (CD-DA)
  The CD-DA is used in for mass market music CDs.
- Write-Once Read-Many (WORM)
  WORM CDs can contain images, text, sound, video, etc. and is a commercial format.
- Compact disc – Recordable (CD-R)
  CD-Rs are like WORMs but are used non-commercially to record images, text, sound, video, etc. CD-Rs cannot be erased or reused.
- Compact disc Rewritable (CD-RW)
  CD-RWs can be used, erased and reused.

The information recorded on CDs is encoded in digital form. The method of encoding the information varies depending on whether the CD is read-only (CD-ROM), (CD-DA and WORM) or writable (CD-R and CD-RW).

Read-only CDs are made from molded polycarbonate with a spiral track of pits which hold the information. The laser reads the information from the pit. Read-only CDs are silver on both sides of the CD.

Writable CDs are made from a molded polycarbonate like read-only CDs but have dyes added to the laminate structure. As the information is being recorded by the laser onto the CD the dye becomes discoloured which results in the information being encoded. Writable CDs appear green, gold or blue on one side rather than silver on both sides.

Storage and Handling

- Store CDs in their polystyrene "jewel cases," polypropylene or polycarbonate cases or other archival plastic. Do not store in paper or card enclosures.
- Store CDs vertically.
- Wear clean, lint-free gloves when handling CDs.
- Handle CDs by their edges.
- Do not bend or place pressure on the CD as this may lead to delamination.
- Store CDs in the dark as ultraviolet light can discolour the lacquer and polycarbonate layers causing laser reading problems.
- Avoid excess humidity levels (above 50%) as early CDs reflective layers have been know to oxidize. Reflective layer composition has changed over the years but excess humidity should still be avoided.
- The life expectancy of a CD varies with the CD composition and storage environment. Currently, the life expectancy is thought to be anywhere from 20–200 years.
- Do not label discs with self-adhesive labels. Consult the disc manufacturer to find out which type of marker pen is appropriate for the disc.

Documentary Art

Documentary art usually comprises a small component of an archives collection. Documentary art can include a variety of media but most commonly includes works of art on paper, oil paintings and acrylic paintings.

	Storage Environment		Storage Enclosure
	Relative Humidity	**Temperature**	
Documentary Art	Recommended 40–45% Acceptable 30–50% +/−3% daily fluctuation	18°C +/−2° cooler if possible	Original frames Works of art on paper – in acid-free buffered mats All framed art should meet conservation framing standards

The primary concern with documentary art usually relates to storage.

Storage and Handling

- If there are a few paintings in the collection and no special storage area for them, hang them on an interior wall.
- Always ensure that the hanging hardware and wire are securely attached and strong enough to support the painting and its frame.

- Vertical storage systems can be considered an alternate to hanging storage. Framed works can be stored in a wooden shelving unit with vertical slots. All surfaces of the shelving should be properly sealed (Tétreault 1999). Place paintings in the slots back-to-back and front to front to prevent screw eyes on the back of one frame from marring the front of another. Insert pieces of Coroplast between the frames to further protect the surfaces. The base of the slots can be carpeted to prevent damage when the frame is moved.
- Documentary art on paper should be matted following conservation standards (see pages 36–37, Chapter 4: Care).
- Do not touch the surface of a painting or work of art on paper.
- Never attempt to clean a painting. If it is very dusty, but has no visible flaking, gently brush the surface with a soft brush.
- Before moving a painting, plan your route, remove obstructions and clear the space where you intend to put the painting. When resting a painting temporarily on the floor, stand it on a pair of padded blocks to prevent the painting from slipping.
- Carry a painting by its frame with both hands, and with its face toward you. Large paintings should always be carried by two people. When handling ornate frames, keep in mind that pieces can break off easily as a result of pressure or impact.

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