Appendix R: Curatorial Care of Photographic Collections

List of Figures

APPENDIX R: CURATORIAL CARE OF PHOTOGRAPHIC COLLECTIONS

A. Overview

1. *What information will I find in this appendix?*

This appendix discusses the composition and physical structure of photographic materials and outlines their long-term care and preservation.

2. *Why is preventive conservation important for these materials?*

All photographic materials are especially vulnerable to deterioration when exposed to:

- inadequate environmental conditions
- improper storage enclosures
- careless handling practices
- damaging exhibition procedures

For this reason, preventive care is absolutely critical to the long-term preservation of these irreplaceable images.

3. *How can I find the latest information on care of these types of materials?*

Watch the following sources for new information and techniques:

- NPS *Conserve O Gram* (*COG*) series
- e-mail NPS Museum Management Newsletter

See the NPS Museum Handbook, Part I (MH-I), Chapter 3, Museum Objects Preservation: Getting Started, for a discussion of preventive conservation and conservation treatment.

B. The Nature of Photographic Materials

Photographs are images formed by the action of radiation, usually light, upon a sensitized surface. While often thought of as a single technique, photography is many hundreds of related chemical processes known by a wide variety of process and trade names. Sources of assistance for descriptions of the various photographic processes are included in Section K

1. *What is the component structure of photographic materials?*

The component structure of photographic materials includes a variety of:

- ***final image materials***, such as silver
- ***binders***, such as albumen, collodion, and gelatin
- ***supports***, such as paper, plastic film, metal, or glass (also called the *base*)

Negatives, prints, transparencies, and slides are all photographs.

The laminate structure of prints is often further complicated by the presence of:

- secondary supports
- additional colorants
- coatings
- adhesive layers

2. *Why should I identify photographic processes?*

Identifying the photographic process (final image material, binder, and base) will allow you to accurately assess the relative short- and long-term stability of a specific photographic object.

3. *What are the basic types of final image materials and how do they deteriorate?*

The image in every photograph is created by materials that absorb and scatter light. Final image materials may include:

- photolytic or filamentary silver
- metallic platinum
- pigments
- organic dyes

The final image material in most nineteenth-century photographic prints is a finely divided ***metallic silver***, identified as "printed-out" or "photolytic" silver. Photolytic, or metallic, silver particles are rounded in shape and scatter light, and, as a result, produce the red or brown image tones associated with nineteenth-century print materials in good condition. Photolytic silver particles are quite small and are extremely susceptible to image deterioration and rapid loss of highlight detail.

The final image material in most twentieth-century photographic prints is ***filamentary silver***, which consists of bundles of intertwined filaments, resembling steel wool, that are huge in comparison to photolytic silver particles. These larger particles are significantly less vulnerable to image deterioration. Their irregular structure absorbs light rather than scatters it. Therefore, filamentary silver images are characterized by a neutral black image color, unless toned with gold, sepia, selenium, or hand-colorant.

All silver images are prone to severe oxidation and, as a result, undergo characteristic changes. Photolytic silver images exhibit general fading throughout, a loss of highlight detail, and a shift in image color toward warmer (more red or yellow) tones. Filamentary silver images, on the other hand, exhibit a significant shift in color from neutral black to yellow brown as they deteriorate.

Mirroring, a dark, mirror-like, reflective tarnish stain caused by oxidation, is a common symptom of deterioration in silver images. It often appears as a bluish, metallic sheen visible in a photograph's dense image areas when examined in reflected or raking light. Silver images also can be adversely

affected by improper processing during manufacture, resulting in a severely yellowed and faded final image material.

In platinum prints, the final image material is ***metallic platinum***. Since platinum is a noble metal, it's not susceptible to oxidation. Therefore, platinum images don't tarnish or fade. Platinum is, however, a catalyst for cellulose deterioration. Platinum prints may exhibit an embrittled and discolored primary paper support.

Pigments, such as lamp black, burnt and raw umber, burnt sienna, and prussian blue, often have been used as final image materials for such printing processes as carbon, gum bichromate, and cyanotype. These pigments usually are dispersed in a binder, such as gelatin, gum arabic, or linseed oil, and tend to have good to excellent overall stability.

Finally, ***organic (synthetic) dyes***, as used in most contemporary negative and positive color processes, are considerably less stable, and will fade both in the dark and upon exposure to light. The destruction or decolorization of organic dyestuffs in color photographs is due to irreversible changes in their chemical structure. Upon exposure to light, high humidity, or high temperature conditions, organic dyes are readily converted to oxidized and often colorless dye fragments.

4. *What are the various types of binder layers?*

The binder in photographic material is the transparent layer in which the final image material is suspended and protected. Binders are important in determining optical properties, such as surface smoothness, gloss, density, and color, as well as the overall stability of specific print materials. The binders most commonly used throughout the history of photography include:

- ***albumen***, a globular protein from the white of hens' eggs
- ***collodion***, a form of cellulose nitrate
- ***gelatin***, a highly purified protein commercially produced primarily from animal hides and bones

Albumen (ca 1850-1900) actively deteriorates and yellows due to the inherent characteristics of the egg white protein and its chemistry. Albumen has a strong affinity for silver ions, and as a result, in processing these materials, colorless silver-albuminate complexes may be formed. Upon exposure to reactive sulfiding compounds, these colorless complexes may be converted to a yellow silver sulfide with a resulting increase in overall discoloration or staining leading to yellowing and loss of detail in non-image (highlight) areas. Albumen yellowing also occurs from prolonged exposure to light and high relative humidity conditions.

The albumen binder will expand and contract when exposed to fluctuating environmental conditions. Albumen prints, therefore, characteristically exhibit severely cracked and crazed binder layers. Albumen images almost always are mounted on a secondary support, since unsupported images will curl into tight rolls.

Collodion (ca 1851-1920) was used as a transparent binder in both glossy-

and matte-surfaced photographic printing papers manufactured at the turn of the century as well as for ambrotypes, tintypes and the wet plate negative

process that was introduced in 1851. Collodion is brittle, and is easily abraded and mechanically damaged when handled improperly.

Photographic ***gelatin*** (ca 1870-present) is a highly purified, homogeneous protein. While it is relatively stable and doesn't yellow severely like albumen, it is very reactive to changes in temperature and relative humidity conditions. When exposed to moisture, gelatin swells up to twenty times its volume, becoming soft and tacky. Finally, gelatin can serve as a nutrient for microbiological or fungal activity in conditions of high relative humidity and also is attractive to insects and vermin as a food source.

5. *What are examples of primary supports?*

The most common primary supports used throughout the history of photography include:

- paper
- glass
- flexible film
- sheet metal

In both historic and contemporary photographic print materials, the image-bearing layer usually consists of a coating on a ***paper-based*** support. When handled improperly, paper supports are susceptible to irreversible mechanical damage in the form of tears, creases, and losses.

In the early days of photography, these paper supports were manufactured from the highest quality rag fiber or chemically purified wood pulp. After 1881, machine-manufactured photographic papers were coated in the factory with a baryta layer, which consisted of the white pigment barium sulfate and gelatin. The baryta layer produced a highly reflective surface, allowing for greater contrast and brilliance in the final print. It also acted as a protective barrier between trace impurities in the primary support and the light-sensitive materials.

Plastic-coated, or resin-coated, photographic papers were introduced in the late 1960s. They were often subject to embrittlement, cracking, and/or localized fading of the photograph's silver image. Within recent years stabilizers have been introduced into these papers. As a result, current plastic-coated papers, when processed correctly, are considered to be as stable as fiber-based supports.

While ***glass*** was the favored image support material in the nineteenth century, these supports may deteriorate under unfavorable environmental conditions. The chemical composition of support glass is the single most important factor pertaining to the long-term preservation of collodion plates. Deterioration of the glass support can result in softening and flaking of the collodion binder and varnish layers as well as discoloration and fading of the silver image.

Nearly all existing still and motion picture ***films***, prior to the introduction of

polyester film in 1955, were produced on a cellulose plastic support. Earlier films were made from cellulose nitrate, first marketed in 1889 and manufactured until 1951. See NPS *MH-I*, Appendix M, Care of Cellulose

Nitrate Negatives. Later films were composed of a variety of cellulose acetate supports. All cellulose plastic bases are subject to hydrolysis upon exposure to adverse environmental conditions, particularly high relative humidity. The hydrolysis of cellulose nitrate film, for example, releases nitrous oxide, a strong oxidizing agent that aggressively attacks image silver and severely embrittles the plastic film base as well as all nearby materials. Cellulose nitrate film base also is highly flammable and will burn underwater, as it produces it's own oxygen during combustion. Valuable cellulose nitrate negatives must be reformatted and placed in cold storage.

In acetate films, acid hydrolysis won't accelerate silver image deterioration. However, the indirect consequences of hydrolysis may result in massive shrinkage and physical deformation, such as cockling, buckling, and channeling of the film base. Furthermore, acid-catalyzed hydrolysis will cause fire-retardant additives, historically incorporated into the film base during manufacture, to be released and deposited as liquid-filled bubbles in the gelatin binder.

Some of the earliest photographic processes used ***metal*** as the image's primary support. A daguerreotype photograph, for example, is a silver-plated sheet of copper with the whites or highlights of the image being a silver-mercury-gold amalgam and the darks pure silver metal. The daguerreotype plate is susceptible to deterioration resulting in the formation of corrosion films, primarily silver sulfide, on the support's surface. Tintypes were manufactured on japanned iron plates. The japanned surface was usually composed of a mixture of raw linseed oil, asphaltum, and lamp black pigment. A tintype's iron support may corrode or rust at the plate's unvarnished edges or anywhere the protective japanned surface has been scratched or otherwise damaged. Corrosion of the iron support may result in irreversible flaking and/or loss of a tintype's image-bearing (collodion) layer.

6. *Are there other structural concerns?*

Yes. When you analyze the component structure of photographic materials, you will also need to evaluate the presence or absence of a secondary support, hand colorants, final coatings (waxes, gelatin, and spirit varnishes such as shellac) and adhesive layers. Photographic prints often have been hand-colored with a variety of media, sometimes fugitive, including watercolors, pastels, and aniline dyes. These additional components can strongly influence the final appearance and stability of all photographic materials. Rubber cement adhesives, for example, can irreversibly stain and yellow binder layers.

C. Preparing a Preservation Strategy

A general understanding of the nature of photographic materials provides a basis for developing a preservation strategy for the collection.

1. *Why do I need a preservation strategy?*

A preservation strategy will help you care for and protect these diversified collections. In establishing a preservation plan, you need to understand and consider many issues pertaining to format and type, condition, housing, value, access, and use. In determining value, for example, you need to ensure that the collection materials support the park's approved Scope of Collection Statement and that these photographs are important for their artifactual, evidential, associational, administrative, or informational value. For example, heavily-used collections of lower value may be granted higher preservation priority when compared with little-used materials of higher value. See *COG* 19/10, Reformatting for Preservation and Access: Prioritizing Materials for Duplication.

Photographic collections should be assessed by a conservator for condition, processes, and format. The conservator should carefully examine all types of items in the collections, including albums, scrapbooks, and newer items such as microforms. Owing to quantity, it is often difficult, if not impossible, to examine all photographic objects in a collection; however, boxes and groups of items can be randomly sampled and assessed for storage, treatment, handling, and exhibition needs. In doing so, the conservator may make a checklist for tracking and quantifying general condition and deterioration problems associated with various photographic items. See Section H for a condition checklist.

2. *What are the basic elements of a preservation strategy?*

A preservation strategy tells you how to do the following:

- monitor, assess and control the environment
- establish handling procedures and a disaster plan
- rehouse photographic images
- reformat color materials and preserve originals in cold storage, where appropriate
- evaluate photographic materials for conservation treatment
- inspect negatives
- duplicate deteriorating materials
- inspect copy images

3. *How should I assess and control the environment?*

Survey storage facilities and exhibition spaces for evidence of the potentially damaging environmental conditions of relative humidity, temperature, light, and pests.

- Maintain the relative humidity (RH) levels for most photographic materials at 20% to 40%. You should strive for this range when storing all types of photos in one area. However, if you are storing only film-base materials, the preferred range is at 20% to 30% RH.
- Store most color and film-base collections at 4.4°C (40°F) or below. When you place collections in cold storage, they should remain in cold storage as much as possible. Therefore, make copy negatives and

prints available for duplication and research use.

- Monitor and control the environmental conditions, especially relative humidity, in collections storage and exhibits to reduce the potential for microorganism growth. When RH reaches 65% and temperature rises above 75°F, the potential for microorganism growth increases.

- Use the photographs at the appropriate light levels. See Figure R.1.

Century	Type of Photograph	Appropriate Light Levels
19th	Most 19th century processes	<50 Lux or 5 footcandles
Late 19th (1880s)-20th	Photographs with Baryta Layers, such as Gelatin Printing-Out Paper, Collodion Printing-Out Paper, and Gelatin Developing-Out Paper	<100 Lux or 10 footcandles
20th	Modern color photographs	<50-100 Lux or 5-10 footcandles

Figure R.1. Appropriate Light Levels for Photographic Media

4. *Should I establish handling procedures and a disaster plan?*

Yes! First, establish handling and preservation procedures that are oriented toward stabilizing the condition of the entire collection.

Then, ensure that these procedures are followed so that the level of preservation is consistent throughout the collection.

Finally, establish a disaster plan to protect the museum collections in an emergency.

5. *Should I rehouse photographic prints and negatives?*

If the photographic prints are in acid-free or acid-neutral housings, you don't need to rehouse them, unless the housing is damaged. In all other situations, you need to rehouse photographic materials in acid-free archival sleeves and folders.

6. *How do I rehouse photographic prints and film negatives?*

If you need to rehouse ***photographic prints***:

- place each print in archival-quality plastic or paper enclosures to prevent damage from chemical deterioration and improper handling

- place the enclosure containing prints in a box or drawer

- place boxes or drawers on shelves or in cabinets

If you need to rehouse ***glass plate negatives*** and stabilize them:

- place negatives in four-fold archival paper enclosures

- place negatives upright on their long edge in padded boxes

- place boxes on shelves
- label boxes "Fragile Glass"

If you need to rehouse ***photographic albums and scrapbooks***:

- box them to protect them from dirt, dust, and gaseous pollutants
- interleave photograph albums with neutral pH tissue

> ***Don't use buffered tissue or acid-free paper.***

- don't use interleaving materials if they will cause stress on album bindings (such as significantly swelling a volume's width)

If you need to rehouse ***daguerreotypes, ambrotypes, and tintypes***:

- house them in acid-free folding boxes
- identify actively deteriorating cover glasses and replace them with contemporary high-grade alumina silicate glass
- have a trained conservator supervise the uncasing and resealing operations

If you need to rehouse ***film-based negatives***:

- place each negative in a sleeve
- place each sleeved negative in a box or drawer
- place each box or drawer on a shelf or in cabinet

7. *How should I preserve color materials?*

After housing, place color photographic materials in refrigeration or cold storage to slow irreversible deterioration. Cold storage promotes a longer life for the photographs being preserved. Even 20°F below room temperature provides many decades of additional life for photographic materials. Store collections of color negatives, transparencies, and prints, in archival housing within Ziplock bags in boxes, in a frost-free refrigerator with low-humidity refrigeration. You may place humidity indicator strips within the bag to help monitor environmental conditions.

If you must remove materials from the cold storage vault, for example if the power has been out for longer than 48 hours, allow the materials to acclimatize at room temperature for several hours before handling them.

> ***Don't forget to monitor the frost-free refrigerator for temperature and humidity levels and to establish retrieval and access guidelines to severely limit the removal of materials.***

8. *How do I evaluate photographic materials for conservation and further*

You should work with a conservator to learn how to identify photographic processes and formats and deterioration characteristics. Check photographic materials for:

preservation?

- active flaking or powdering
- mold growth
- tape or adhesives present
- severely deteriorated supports

Ensure that photographic materials with these conditions receive conservation treatment.

9. *Who should inspect film-base negatives?*

You should work with a conservator to:

- inspect film-base negative collections and evaluate them for deterioration
- establish duplication programs
- develop handling guidelines
- establish archival storage procedures

10. *What about reformatting and duplicating deteriorating materials?*

You won't always be able to preserve all photographs in pristine condition. When faced with massive deteriorating photographic holdings, you will need to strike a balance between stabilization, treatment, and duplication.

Some processes, such as cellulose acetate and cellulose nitrate negatives may totally self-destruct over time in a normal storage environment. The self-destructive images are said to have inherent fault or inherent vice. The only way to preserve cellulose nitrate and cellulose acetate negatives may be permanent cold storage. In order to save the informational content of these negatives, it is necessary to duplicate these images using more stable materials. See *MH-I*, Appendix M, Care of Cellulose Nitrate Film, and *COGs* 19/10 through 19/13 on preservation reformatting.

Other photographic materials, while not as prone to self-destruction as cellulose acetate or cellulose nitrate, will deteriorate as a result of use, such as exhibition, regular handling, or frequent duplication. These heavily used materials will also benefit from duplication, as the duplicates may become the copies for use while the originals are preserved in cold storage.

Some scholarly researchers may still need to view the originals in order to study the image's process, format, or technique. In most cases, researchers are interested in the informational value of an image. Informational values may be captured in high-quality photographic copies.

If you need to rehouse and/or duplicate film-base collections, carefully consider the following options:

- ***Interpositives***. For maximum quality control during duplication, you should produce an interpositive (intermediate positive image on clear film). Make this interpositive from the original negative by contact printing the image onto a sheet of clear film, producing a positive transparency. Then, make a laterally correct (not reversed) copy

negative from the interpositive. Retain the interpositive to serve as an archival master used for the creation of additional copy negatives. Use

the copy negative as the duplication master to produce copy prints for staff and researchers. Keep the original negative in cold storage.

- ***Direct Reversal Film***. Another procedure requires the use of direct reversal film, to produce a direct but laterally reversed duplicate negative. The resolution of direct-duplicating film is good, although tone reproduction can be poor. Because of their fine-grained structure these films are prone to oxidation leading to silvering out and mirroring, hence image detail loss. These images must be accurately processed and toned during use and carefully inspected and tested after creation. Such requirements make the actual cost of direct duplicates equivalent to interpositive processes without providing the same quality of images. Request either polysulfide toning or gold toning which will extend the life of the negative. Be aware that gold toning can add 20-50% to the cost. In many cases, direct reversal or direct duplicate images, also known as direct positive images, don't produce publication quality negatives.

  Selenium toner was frequently recommended for use with all copy negatives, particularly direct duplicate negatives. However, the Image Permanence Institute (IPI) in Rochester, New York has found that selenium may not adequately protect a filamentary silver image in low density regions from oxidative attack. Don't request selenium toning of photographs. IPI is currently investigating the use of a polysulfide toner to which a small percentage of borax is added. For additional information, contact the Image Permanence Institute, Rochester Institute of Technology, 70 Lomb Memorial Drive, Rochester, NY 14623-5604, 716-475-5199.

- ***Copy prints and camera negatives or long-roll camera film***. Other duplication options to consider include producing of copy prints and camera negatives from the original negative or using a long-roll camera film for efficient and cost-effective duplication of large collections. As with direct reversal film, these processes won't necessarily produce publication or exhibition quality copies and some of the images' informational value may be lost.

When you are faced with massive deteriorating film holdings, consult a conservator. See *COG* 19/10, Reformatting for Preservation and Access: Prioritizing Materials for Duplication. You should carefully evaluate the available duplication options discussed above and consider the following factors:

- collection's size
- informational value
- evidential value
- associational value
- administrative value

- artifactual value
- condition
- projected use
- funding and staffing resources available

Collection value, usage, and risk or stability probably should determine which items you duplicate first. Don't dispose of original negatives once duplicated unless they are in an advanced state of deterioration.

Finally, you should establish two regular inspection programs:

- One should evaluate the technical and archival quality of the duplicate negatives. Compare the duplicate's optical, tonal, and physical characteristics with the originals. See *COG* 19/13, Preservation Reformatting: Inspection of Copy Photographs.
- The other should be used for all deteriorated film holdings. Select envelopes from every drawer at random and examine them for signs of deterioration as mentioned above. Note incipient deterioration so that you can monitor specific materials during the following inspections. Inspect collections with unregulated climates and generally poor conditions as many as four times per year.

11. *Who should inspect copy images?*

You should have all interpositives, negatives, prints, and slides, whether produced internally or by an outside photographic studio, inspected upon return.

All photographic copy work done for preservation purposes should be done to American National Standards Institute (ANSI) standards. Cite these standards in all contracts with photographers. Don't pay for duplication until after the copies pass inspection. Inspect the copy versus the original for: resolution, tonal range, completeness of image, and residual levels of chemicals. Materials that don't pass inspection criteria should be reshot at the photographic laboratory's expense. See Section K for a list of the appropriate standards.

Have someone experienced in reading negatives and in darkroom work, such as a photographer (other than the photographer who did the copy work), inspect all images. Inspection requires experience and a trained eye. See *COG* 19/13, Preservation Reformatting: Inspection of Copy Photographs.

D. Preventive Conservation: Handling Photographic Collections

All photographic materials, color as well as black-and-white, may be irreversibly damaged by fingerprints, scratches, abrasions, and other forms of mechanical damage or mishandling. Here are some guidelines.

1. *How do I handle photographic prints?*

Historic photographic prints may be irreversibly damaged if handled carelessly. The surfaces of these prints are delicate and, therefore, easily scratched, abraded, creased, cracked, or torn.

General guidelines for ensuring object safety during any handling procedure are outlined in *MH-I*, Chapter 6, Handling, Packing, and Shipping Museum Objects. Some basic principles for the safe handling of historic and contemporary photographic print materials are listed below.

- Prepare a clean and uncluttered workspace for the safe handling of photographic collections. Instruct staff and researchers on the proper ways to handle photographs.

- Establish and enforce handling guidelines (for example, restricting food, drink, smoking, the use of pens) for all staff.

- Wear gloves when accessing collections that aren't protected by enclosures and when handling photographs that require temporary removal from paper or plastic sleeves. Research at the National Archives of Canada shows that immediate interactions will occur between salt in human perspiration and a photograph's final image material. These interactions result in irreversible oxidation of image silver to silver chloride followed by image staining or mirroring where the fingers touch the image. Staff and researchers who are required to wear cotton gloves will often approach a photographic collection with additional care and respect.

- Use temporary or permanent auxiliary supports (such as pH neutral board) during handling if necessary. In all instances, handle the auxiliary support and not the object itself.

- Exercise special caution when using plastic sleeves. Clear plastic sleeves are often too flexible to prevent structural damage. Slip a piece of archival bond (neutral pH) behind the image back before placing it in the sleeve. Transcribe any information from the back of the image in pencil to the back of the archival bond.

  Removing unmounted photographic prints from their polyester sleeves may prove difficult because of the static charge of the polyester film. Slit the plastic sleeve at a sealed edge and gently separate the cover sheet from the photograph by rolling it away from the object's surface.

- Control access to all collections. Using copy prints and/or xerographic copies will greatly reduce handling and subsequent damage. Restrict the photocopying of all original materials. In doing so, maintain and use a "master" set of xerographic copies for all subsequent photocopying. See *COG* 19/4, Archives: Preservation Through Photocopying, and 19/7, Archives: Reference Photocopying. Any collection that is regularly reproduced should have an effective system for creating master negatives so that originals need not be constantly photographed.

- Establish current inventories, finding aids, and container (such as box or folder) lists for all photographic collections to further reduce unnecessary handling.

2. *How do I handle daguerreotypes, ambrotypes, and tintypes: cased and uncased formats?*

You should consider the daguerreotype, ambrotype or tintype and its original housing as a total artifact deserving protection as a whole. Don't disturb these housings unless absolutely necessary. If for any reason you remove an original housing, carefully label and retain them.

If you remove an original housing, use a small suction cup to carefully lift the "photographic package" out of the miniature case interior. This maintains proper configuration and orientation of the fabric liner that serves as a "compression seal" within the case and further protects the photographic image from oxidation. Don't use a suction cup if the brass mat and tape assembly are damaged or not present.

Do not disassemble the photographic package without the supervision of a trained conservator.

Restrict the handling of all original material to only those researchers who are working on images as evidence of connoisseurship issues or those who can't obtain sufficient information from the copy. All other researchers should use copy prints. Secure totally unprotected daguerreotypes and ambrotypes immediately. See Section G. Separate them from the collection to ensure protection against casual handling. Use a Form 10-645, Archives and Manuscript Collections, Separation Sheet to maintain the link between the object and its original location within the collection. See NPS *Museum Handbook*, Part II, Appendix D, Museum Archives and Manuscript Collections for guidance on this form. The surfaces of primary images may be damaged by careless handling because they are very fragile.

Caution both researchers and staff not to open a case completely (180 degrees) when viewing an image as this may cause severe stress on the hinge. Don't use the metallic clasps as they tend to abrade the surrounding leather or paper on the case. If the case is warped, locking the case may break the spine.

Remove loose surface dirt from the case's interior and exterior surfaces with a soft brush. Don't use other cleaning methods because the unprotected surfaces of both daguerreotypes and ambrotypes are extremely sensitive and must be handled with utmost care. Only a trained conservator should clean these materials following a careful assessment of need.

3. *How do I handle glass plate negatives and transparencies?*

Collodion and gelatin glass plate negatives and transparencies are very susceptible to damage. Their weight, bulk, and inherent fragility often pose the potential for serious handling problems. When handling glass plate collections, follow these guidelines carefully:

- Never underestimate the weight of glass. When working with these materials, be sure to have a firm grip on all enclosures in which glass plates are housed.

- Always handle glass on a padded and smooth work surface. You can

construct this type of surface by padding a rigid piece of eight-ply board with successive layers of unbleached linen followed by sheets of lens tissues attached to the reverse of the work surface with pressure sensitive tape. As the surface becomes dirty, the sheets of lens tissue can be easily removed.

- Never handle the emulsion surface of a glass plate negative or transparency directly. Wear unpowdered latex gloves, since cotton gloves may be awkward and are inappropriate for the handling of glass artifacts.

- Before removing glass plate negatives or transparencies from their original (and often opaque) storage enclosures, always examine them carefully to determine the negatives' condition. In some cases, binder layers may be actively flaking and/or partially adhered to their enclosures. Glass supports may be broken or cracked. Safe removal may require that the original enclosures be slit at two edges with a microspatula and the plate carefully removed without scratching the glass or emulsion.

- Duplicate these fragile materials whenever possible. Use the copies for duplication services and reference purposes in order to avoid unnecessary handling of the original materials.

4. *How do I handle film-base black-and-white negatives and transparencies?*

Carefully restrict access to all film negative or transparency collections. The chemical by-products of deteriorating film could be dangerous to staff and visitors, resulting in skin and eye irritation, headache, nausea, and respiratory difficulty

You can mitigate these effects by taking the following precautions:

- Improve room ventilation and air quality by changing the position of supply air registers and the overall level of air movement

- Use fans to maintain air movement while working with these collections

- Wear protective gloves at all times when handling film collection material

- Wear an appropriately rated respirator when handling large quantities of these materials. Respirators are not considered protective if facial hair interferes, because a proper fit cannot be assured. The respirators must be fitted to each employee. See NPS-50, *Guideline for Loss Control Management*, Release No. 2, Chapter 32, Respiratory Protection Program, for detailed guidance.

- Limit exposure time by staff and visitors

See *MH-I*, Chapter 11, Curatorial Health and Safety, for additional guidance.

5. *How do I handle slide collections?*

- Handle slide collections carefully to protect them from physical damage, fingerprints, and dirt.
- Don't leave slides in illuminated viewers or on light tables for longer than is absolutely necessary. (Kodachrome slides are particularly sensitive to light fading.) Also, don't leave slides uncovered on desks and table tops, as this exposure to ambient light may induce irregular fading and image deterioration.
- Keep the projection time for original slides to a minimum and use expendable duplicates whenever possible.
- Don't use high-intensity xenon arc projectors or other projectors that have been modified to increase their light intensity. It is usually light, and not heat, that causes fading when a slide is projected. (Some slides, however, may be more susceptible to heat-related damage, such as those with silver images including Polaroid Polachrome instant color slides and all types of black-and-white transparencies.)

E. Preventive Conservation: Storing Photographic Collections in the Proper Environment

Environmental stability is essential to the longevity of all photographic collections. Where different types of photographic collections are stored in one space, you will need to set up many microenvironments in boxes or cabinets. Find the mean average humidity of what all materials in the room may need and use silica gel, humidifiers, or dehumidifiers as necessary to adjust the relative humidity. Specific materials need specific preventive conservation measures.

1. *How do I store photographic prints?*

Store photographic print materials at a **constant** relative humidity (RH) between 30% and 50%, in dark storage (boxed). Avoid RH fluctuations of more than 5%. Exposure to high relative humidity levels dramatically accelerates the rate of deterioration and can result in the oxidation of silver image materials, binder layer staining, mold, and even permanent changes in size and shape. Excessively dry conditions, on the other hand, may cause cracking, crazing, and embrittlement.

Store most photographic prints at 20°C (68°F) or below. Store contemporary color print materials at 4.4°C (40°F) or below.

The fading of color images is primarily controlled by the storage temperature and to a lesser degree by relative humidity. In all cases, carefully monitor temperature and relative humidity levels as described in *MH-I*, Chapter 4, Museum Collections Environment. See Figure R.2 for relative humidity and temperature requirements for various media.

Also, you will need to monitor and control (through air filtration) the levels of particulates and gaseous pollutants such as nitrogen dioxide, sulfur dioxide, hydrogen sulfide, and ozone.

Type of Photograph	Storage Temperature	Storage RH (Relative Humidity)
Most photographic prints, black and white negatives, direct positives, and transparencies	<68°F (20°C)	30-50% RH
Ambrotypes, daguerreotypes, and tintypes (Cased and Uncased)	65-68°F (18-20°C) ±2°	40-50% RH
Glass plate negatives and positives	68°F (4.4°C) ±2°	35% RH±3%
Black-and-white silver gelatin film based negatives cellulose nitrate and acetate	As low as possible	20-30% RH
Color photographic prints, negatives, slides, and positive transparencies	35-50°F (2-10°C)	20-30% RH

Figure R.2. Relative Humidity and Temperature Requirements for Photographic Media

2. *How do I store daguerreotypes, ambrotypes, and tintypes: cased and uncased formats?*

Daguerreotypes, ambrotypes, and tintypes are composed of a wide variety of materials. Store them at a RH of 40%-50% and temperature of 18°-20°C (65°-68°F).

Brass mats and preservers and iron supports of tintypes corrode at high relative humidity levels. Also, the glass used in glazing materials or actual supports for these photographic images is often chemically unstable. Don't store them in relative humidity conditions above 50% RH. On the other hand, leather, paper, and wood may become embrittled and cracked if stored in very dry conditions, contributing to structural deformations of the case. Maintain the relative humidity for these materials above 40%.

3. *How do I store glass plate negatives?*

Historic glass plate negatives are complex, laminate objects that require specific and controlled storage environments. The safe relative humidity range for the storage of glass plate negatives at room temperature conditions is 35% ± 3%. Avoid temperature and relative humidity fluctuations.

If the relative humidity is too low (below 30%), you may see severe flaking of the image-bearing layer from its glass support. If RH is too high (greater than 40%), you may see glass corrosion, silver image deterioration, microbiological attack, and even physical damage to the binder layer and varnish coatings.

4. *How do I store film-base black-and-white negatives?*

One of the most pressing problems facing large photographic holdings is the active and rapid deterioration of their film-base negative collections. Many unique images exist only as negatives. You will need to give the preservation of their informational content the highest priority.

Store these materials at 20%-30% RH and at temperatures as low as possible.

A very significant increase in film life is possible when storage humidity is lowered below 50%. Lowering the RH from 50% to 20%, for example, can improve expected film life four-fold.

Some other storage considerations for film-base negatives:

- Use a cold storage vault or commercially-available frost-free refrigerator or freezer to retard deterioration and prevent irreversible loss. Select these units carefully and monitor them routinely for temperature and relative humidity levels. See Section F.10.
- Restrict access to the materials housed within these units to staff who have been instructed in the procedures for collection retrieval of refrigerated or frozen items.
- Pack the negatives carefully in boxes. House negatives in Ziplock brand bags with humidity indicator strips.
- Use copies to access the original negatives in cold storage for copying or reference. If you must remove the originals for any reason (such as if you have a power outage of greater than 48 hours) allow them to acclimatize at room temperature for several hours before allowing access and use.
- Store deteriorated film-base collections in a well-ventilated location.
- Segregate nitrate films from other collections, preferably in their own freezer.

5. *How do I store color photographic collections?*

Color materials, including color negatives, slides, positive transparencies, and prints, are considerably more complex in construction than contemporary black-and-white materials. The storage environment is important.

Store these materials at 20-30% RH with a maximum temperature of 2°-10°C (35°-50°F). Store them for long-term at the lower rate, and be sure to avoid cycling. With color print, negative, transparency, and slide collections, storage *temperature is the most significant factor* in determining the rate of image fading and staining. Each -12°C (10°F) reduction in temperature will approximately double the life expectancy of color materials, as long as they aren't removed regularly from cold storage. High RH levels (greater than 65% RH) will promote the growth of fungus on emulsions, resulting in irreversible damage.

Color photographs are typically composed of at least three separate dye layers, consisting of cyan, magenta, and yellow organic dyes. The specific deterioration of these color photographic processes is often characterized by an overall loss of density; shifts in color balance caused by the unequal fading of the cyan, magenta, and yellow dyes; changes in contrast; loss of detail; and overall yellowish staining.

In addition, color photographic prints may crack and delaminate due to exposure to light or to widely fluctuating relative humidity.

6. *What characteristics do I need to know about color photographic collections?*

Color image deterioration is the result of inherent instability of organic dyes. Consult Henry Wilhelm's and Carol Brower's book, The Permanence and Care of Color Photographs: Traditional and Digital Color Prints, Color Negatives, Slides, and Motion Pictures for more specific information on identifying and categorizing these unique deterioration characteristics.

- ***Dye fading that occurs in dark storage.*** Like light fading, dark fading stability is also specific to the type of color film or print materials. The rate of dark fading is primarily a function of temperature and typically results in a final shift in color balance, as the cyan, magenta, and yellow dyes fade at differing rates.

  Some color processes, such as Ilfochrome and Kodak Dye Transfer, are very stable in the dark. Kodachrome slide film is more stable in dark storage than Ektachrome slide film. Ektachrome, however, is more stable than Kodachrome if they are routinely projected.

- ***Dark storage yellow stain formation.*** This type of deterioration typically occurs with some color (chromogenic processes, including Kodachrome and Ektachrome) materials and often is a more serious problem than dye fading. For example, many Kodacolor prints dating from 1942-1953 now exhibit severe yellow stain formation especially prominent in their margins. This discoloration is caused by the unstable magenta dye-forming color couplers that remained in these prints following processing.

- ***Choice of processing method.*** The method of processing (stabilized or water wash) will often directly influence final image stability and the rate of stain formation. The image stability of instant color photographic processes (a stabilized process), for example, is very poor. Objectionable levels of yellowish stain may be observed in these stabilized, non-water washed materials after only a few months of dark storage.

- ***Processing shortcomings.*** Decreased dye stability and/or increased stain levels may result if color materials are processed using improperly replenished or contaminated chemicals or if the photograph isn't washed adequately so that residual processing chemicals remain. See Section G for a list of ANSI standards.

- ***Image fading, staining, or physical deterioration.*** These factors may be worsened by post-processing treatments. The application of lacquers, retouching materials, and high-pressure mounting techniques may adversely affect a photograph's final image stability.

F. Preventive Conservation: Housing Photographic Collections

1. *How do I house photographic prints and negatives?*

Consider funding and staffing, environmental conditions, and the use of the collection when deciding which type and style of enclosure to use. Individually folder, sleeve, or interleave mounted and unmounted photographs within acid-free boxes or stainless steel file drawers. Suitable photographic enclosure materials may be composed of chemically stable plastic or unbuffered, neutral pH paper materials. See *COG* 14/2, Storage Enclosures for Photographic Prints and Negatives.

Use the following guideline when selecting and ordering supplies, and require that the vendor meet its specifications: ANSI Standard IT9.2 1991, *Photographic Processed Films, Plates and Papers - Filing Enclosures and Storage Containers* (see Section K).

See the NPS Tools of the Trade (TOT), A Listing of Materials and Equipment for Managing Museum Collections, for sources of housing materials as well as other curatorial supplies discussed in this appendix.

2. *What about paper photographic storage enclosures?*

Paper storage materials must have passed an accelerated aging test known as the Photographic Activity Test (PAT). (Check with the vendor.) The PAT determines whether there will be harmful chemical or physical interactions between a photograph and its paper enclosure over its storage lifetime. (The PAT is described completely in ANSI IT9.16-1993.)

Photographic storage enclosures made of paper should have a high alpha cellulose content, a non-degraded form of cellulose frequently found in high-rag-content paper most desirable for paper to be permanent. Paper enclosures should contain no lignin, ground wood, or alum-rosin sizing. Printing ink shouldn't bleed or transfer, nor affect the image of the photograph.

The enclosure materials should be pH neutral at 7-7.5, and the paper *must be unbuffered* (not have an alkaline reserve). Current research, however, indicates that using buffered enclosures to house salted paper, albumen, gelatin, platinum, and collodion processes isn't detrimental provided humidity levels are maintained. It isn't necessary therefore to replace present buffered enclosures with unbuffered materials; however, purchase unbuffered paper enclosures when choosing new supplies.

Contemporary color processes, most particularly dye transfer and cyanotypes, require the use of unbuffered papers and enclosures.

There are a number of advantages and disadvantages in using paper enclosures for photographic storage. They are easy to write on and are generally less expensive than plastic materials. They are opaque, thereby protecting photographs from light. Unfortunately, this requires the users to remove each photograph from its individual paper enclosure prior to examination, which increases the possibility of damage.

All enclosures should be standardized and made to fit easily in acid-free boxes. Identify the photographic image in pencil on the outside of each folder before inserting the print.

Paper enclosures are available in several forms including envelopes, seamless enclosures, and folders. Try to use the four-fold seamless storage enclosure; it has no adhesive seam to attract moisture and contribute to image deterioration. You can easily remove the image from the enclosure without danger of abrasion. You can, however, support fragile materials on two-ply ragboard (of neutral pH bond) by placing the ragboard behind the image within the envelope to provide better support.

You can also place prints in individual acid-free folders, even placing several photographs in one folder. In this situation, interleave each photograph with a neutral pH, unbuffered sheet of paper which has been cut to the size of the folder. Don't place more than 15 items in a single folder.

Various types of unbuffered paper envelopes are available from conservation supply companies. Use envelopes with a narrow side seam, sealed with a non-hygroscopic and non-reactive adhesive, rather than a thick central seam. During storage, be sure the emulsion or binder side of the photograph faces away from the seam. Use envelopes with a top flap, as the flap prevents dust from entering the envelope. Each envelope should only hold one photograph; when this isn't possible, interleave them.

Don't use glassine or kraft paper envelopes for photographic storage.

You can mat mounted and unmounted photographs with 100% acid-free neutral pH ragboard window and back mats. See *COG* 13/1, Window Mats for Paper Objects. Fragile, damaged or severely warped mounted photographs as well as all photographs exhibiting a flaking binder layer may require sink mat and mount housing for additional protection. A sink mat is a museum mat for paper objects that has a recessed section in the bottom sheet that protects the paper object from contact with the overmat or cover sheet. Use sink mats for photographs that have been hand-colored with friable media such as charcoal, pastel, conte crayon, and similar media that can easily be smeared, as well as for photographic prints that have damaged surfaces.

Never dry mount onto secondary supports or laminate previously unmounted photographic prints.

Matted photographs may be hinged into their back mats with long-fibered Japanese tissue hinges attached with wheat starch paste, or mounted with good quality paper photo corners. Don't use polyester photocorners, particularly on fragile images, because they can cause abrasion. Don't use hard plastic corners or flanges because they may not be chemically neutral and some have sharp edges that may scratch, abrade, or emboss a photograph.

Paper photo corners, which should be as large as possible, are the most convenient and safe means of attachment when used properly. You can fabricate these in-house from acid-free dense paper or purchase them from a conservation supply company. See *COG* 14/1, Making Mounting Corners

for Photographs and Paper Objects. Any photograph with edges covered by the window mat may be mounted this way if it is strong enough to withstand its own weight resting on its lower corners while on display. The corners should be loose around the outer edges, to allow the photograph to expand with changes in relative humidity.

Reinforce the corners with a strip of archival quality linen tape or with pressure-sensitive tape adhered to the back mount. (The recommended pressure-sensitive tape for archival purposes is 3M 415 double-sided, polyester transparent tape coated with an acrylic adhesive.)

For storage, insert a sheet of unbuffered, lightweight neutral pH paper or polyester film between the photograph and the window mat to guard against abrasion. Examine carefully previously matted materials to determine their construction and materials stability.

3. *What about plastic photographic enclosures?*

Use plastic enclosures because they have the advantage of allowing an image to be viewed without removing it from the enclosure. This technique *greatly* reduces the possibility of handling damage and is ideal for large, high-access collections that haven't been copied.

If you use plastic enclosures, give special concern to humidity control. Photographic emulsions may stick, or "ferrotype," to the slick surface of these materials.

Use plastic materials ONLY if you can maintain relative humidity below 70%.

Suitable plastic enclosure materials include uncoated polyester and polypropylene. Don't use the following materials for housing photographic prints, negatives, transparencies or slides: chlorinated plastic such as polyvinyl chloride (PVC) or polyethylene sheeting, highly plasticized sheeting or coatings, or cellulose triacetate film.

Because of the build-up of static electricity, don't use plastic materials, especially polyester film, for housing photographs that have a flaking or friable binder layer or applied color.

Don't use plastic housing materials for images on glass, either negative or positive, as they are very prone to image flaking.

Also, one side of some polyester film photographic storage sleeves are slightly matted to avoid ferrotyping. The matting is done with silica dioxide or through roughening of one surface. Don't use these "matted" or "frosted" films for photographic storage.

You can choose from a wide variety of plastic enclosure designs available from conservation supply companies. Here are a few examples:

- ***Plastic sleeve.*** The sleeve is a plastic enclosure that opens along two or three sides. One particular polyester sleeve design you may want to use opens along both long sides with a flap. The flap allows inserting and removing of the photographs without potentially dangerous sliding.

"L" sleeves, sealed along a long and short edge, also allow for easy and safe access to a photographic print.

You can cut neutral pH, unbuffered mat boards (.01"-.02" thickness) to standard sizes and then insert them into the plastic sleeve, behind the photograph. The clear plastic sleeve allows the photograph to be viewed without being removed, and therefore protects the photograph from scratches, dirt and fingerprints. The neutral pH, unbuffered board neutralizes acids, provides fragile photographs with additional support, and allows the print to be identified without labeling directly on the image.

Take care when handling sleeved photographs, since they may slip or fall out of the open sides of the enclosures.

- ***Polyester folder.*** This enclosure is made by welding two sheets of polyester film together along one edge. These folders are most successful when used inside neutral pH, unbuffered paper envelopes. The polyester folder protects the photograph from handling whenever you remove it from the envelope.

- ***Polyester sheet with multiple pockets.*** You can use this system for housing small mounted and unmounted photographic prints within a larger-sized standard folder. It consists of two polyester film sheets that have been welded together to form standard-sized clear polyester film pockets or pouches. To maintain the original order of a collection, all images should be of the same size if this system is being used. Therefore, it may not be practical for a varied size collection.

- ***Unbuffered acid-free folder with polyester film overlay.*** This paper folder has the addition of a sheet of clear polyester film attached to its inside, along the right margin. It can be made in-house or purchased from archival vendors. This storage enclosure is particularly effective for housing unmounted and fragile albumen photographs that often have a strong tendency to curl.

- ***Polyester/ragboard enclosure.*** These "handling folders" are available commercially in standard sizes. They consist of a sheet of polyester film adhered at two edges in an "L" shape, adhered to a fractionally larger sheet of four-ply buffered acid-free ragboard. The photographic print is slipped under the polyester sheet and housed flat. This enclosure provides unmounted and fragile photographic prints with additional protection. However, mounted photographs are more likely to slip and slide within it, so this design isn't appropriate for all photographic formats.

4. *How do I house panoramic (oversized) prints?*

Panoramic prints, usually longer than "normal" photographic prints, are often found in a tightly rolled and vulnerable configuration. While you can flatten a loosely rolled print by placing it between two pieces of clean, dry, blotting paper under weights, many tightly rolled prints will crack and tear irreversibly if forced open without the proper humidification and flattening procedures. Consult a trained photographic conservator if in doubt.

You can house flattened panoramic prints in polyester film sleeves with a fold-lock closure at the long edge. You can purchase pre-welded lengths of

rolled polyester in a variety of widths that can be cut to size as required. You can also insert a four-ply ragboard support into the sleeve for increased protection. Be sure to transfer any identification information from the back of the print to the back of the board *before* housing the print in the sleeve.

You also may house panoramic prints flat in heavy-weight paper folders. In some instances, it may be necessary to house these large format materials rolled onto neutral pH unbuffered tubes. Take care that the diameter of the tube is sufficiently large (4" or greater) to ensure adequate protection of the photograph. Once rolled with the binder side inward, cover the tube with polyester film, attached with a velcro button closure.

5. *How do I containerize sleeved prints?*

Once they are housed in individual storage enclosures, you can place photographic prints in acid-free file folders and special acid-free storage boxes that are free of lignin, ground wood, and alum-rosin sizing. Paper and board stock used to construct these storage boxes may be buffered (have an alkaline reserve). Use flat storage, in shallow acid-free boxes or flat file drawers, for fragile photographs and those that are adhered to brittle mounts. Be sure that all folders or enclosures exactly fit the inner dimensions of the storage box, so that they will stack neatly and not shift dangerously.

If they are in generally good condition, you can store 10" x 12" or smaller photographs upright in boxes or acid-free hanging file folders. Boxes and file cabinets must not be overcrowded, but also must not be so loosely filled that all support is lost. Equip vertical file drawers with rigid support of metal or acid-free mat board every 6"-8".

Fire resistive (insulated) filing cabinets are not recommended because they don't use space efficiently. They also are bulky for storage areas, and very expensive. A better storage method is to house photographs upright in boxes on steel shelving units.

6. *What storage techniques do I use to rehouse photographic materials?*

No single storage system is ideal for all photographic materials. Base your storage decisions upon format, type, condition, use, and value of the photographs. Those materials that are most heavily used should probably be rehoused first, followed by original photographic prints of high value and/or in fragile condition. A strategy for setting priorities is described in *COG* 19/10, Reformatting for Preservation and Access: Prioritizing Materials for Duplication. In order to reduce damage caused by handling, house those photographs most often used and requested in plastic enclosures. In all cases, use standard-sized storage enclosures only.

Photographic objects are particularly susceptible to the potentially reactive and volatile by-products released by some of the materials used in the manufacture of storage cabinets. Use only galvanized or stainless steel cabinets or steel cabinets coated with a baked-on-enamel finish or non-reactive powder coatings. These powder coatings are made by electrostatically applying powdered epoxy resin that is fused to the enamel finish with heat. No solvents or plasticizers are used in the process.

Remove paper clips and staples from all photographs before storing them. Rusty paper clips or staples or other metal attachments may permanently stain, fade, emboss, and/or tear photographic prints. See *COG* 19/5, Removing Original Fasteners from Archival Documents.

During rehousing, examine all photographic items to assess the need for further preservation treatment. Learn to identify those deterioration problems that require immediate conservation treatment, such as photographic materials exhibiting actively flaking binder layers, the presence of pressure-sensitive and rubber-cement adhesives, and severely deteriorated and embrittled primary and secondary supports.

The presence of active mold growth is another critical problem that you should address immediately. You can prevent continued bio-deterioration by removing spores via aspiration, and then controlling the environment stringently.

7. *How do I house daguerreotypes, ambrotypes, and tintypes: cased and uncased formats?*

These objects are frequently found housed in their original decorative folding cases that were often constructed of wood covered with embossed leather or paper. The photographic images are protected by a lacquered brass mat and a cover glass, usually bound together with paper tape and further covered with a decorative brass foil or preserver.

Each miniature-cased object should have individual housing protection in the form of a wrapper or container that conforms to its three- dimensional format. You can house cased photographs in individual, custom made, four-flap boxes of heavyweight acid-free folder stock. Boxes are also available from a variety of conservation suppliers in stock sizes.

Write the catalog number and other identifying information in pencil on the outside of the box. If possible, use acrylic adhesive on 3M mounting tape to adhere a 35mm contact print of the image to the outside of the storage box to help minimize handling of these fragile artifacts. Store the arranged cases flat, by size, in acid-free boxes or padded drawers. Vertical storage may be necessary for larger collections where space is a problem.

- ***Loose daguerreotype plates***. These materials are extremely vulnerable, so give them the highest priority for protective housing. This may consist of a sink mat (see Section G), alumina silicate cover glass, and a pressure-sensitive tape seal. The sink mat may be fabricated from an acid-free unbuffered ragboard or die cut from 60 point polypropylene sheeting. To ensure adequate protection, use ragboard that has passed the PAT. When purchasing ragboard, check vendor's specifications. Filmoplast P-90 and Permacel J-Lar 4000 pressure-sensitive tapes have been successfully used for binding daguerreotypes. These chemically stable tapes are both manufactured using an acrylic adhesive. J-Lar provides a better barrier to moisture. The specific composition of these tapes may change in time. Therefore, rehoused daguerreotype plates must be carefully monitored to ensure that their deterioration isn't progressive.

  Identify actively deteriorating cover glasses and replace them, as time permits, with contemporary glass. Ask a conservator to supervise all uncasing and resealing operations.

- ***Loose ambrotypes***. House loose ambrotypes in four-flap neutral pH paper enclosures or envelopes. Protect the glass support from breakage by including a four-ply neutral pH ragboard sheet. House broken or cracked ambrotype supports in a sink mat, or sandwich them between

two sheets of ragboard to await further treatment. Note that the ambrotype's surface is easily abraded and scratched, although the surface isn't as delicate as the daguerreotype's surface.

- ***Loose tintypes***. House loose tintypes in good-quality paper or plastic, such as polyester and polypropylene film, enclosures. Four-ply ragboard inserted behind the tintype will provide its flexible support with additional protection. House sleeved tintypes vertically in acid-free boxes (never in plastic enclosures).

For tintypes that exhibit a flaking collodion binder layer, use four-flap paper enclosures only.

8. *How do I house glass plate negatives and positives (lantern slides)?*

Use a four-flap neutral pH paper enclosure for storing glass plate negatives and lantern slides in good condition. These enclosures should meet ANSI IT9.2 specifications (see Section K).

Storing each plate in its own enclosure prevents rubbing and abrasion on the plate. When using the four-flap enclosure, place the glass plate image in the center with each flap carefully folded over the emulsion side. This avoids the necessity of sliding the image in and out of the enclosure. Write any pertinent information in graphite on the outside of the seamless enclosure before the image is inserted. Some commercially made paper sleeves aren't suitable for glass plate storage, as photographic emulsions can be irreversibly damaged through the action of sliding the plate in and out of an envelope.

Never use plastic sleeves, envelopes, or folders with glass plates. Don't place glass plates in cold storage.

Caution: Only excessively dirty materials and/or those designated for duplication require cleaning. You should only attempt this cleaning after determining the emulsion side of the glass plate, usually the less glossy side. (If a question remains, consult a conservator.) During rehousing, carefully clean the non-emulsion or base side of the glass plate with a soft brush followed by a cloth slightly dampened with distilled water. Don't allow moisture to come in contact with the emulsion side of the glass plate.

House all glass plates according to size after making careful notes on their original order. Store glass plate negatives and lantern slides that are in good condition and smaller than 10" x 16", vertically (upright) on their long edge within the sleeves. Store them in metal file drawers or in acid-free, flip-top, reinforced boxes that contain no lignin, ground wood, or alum rosin sizing.

In each case, cut pieces of four-ply neutral pH ragboard to the size of the enclosures and place them as rigid dividers between every five to ten individually enclosed plates. These dividers will help support the weight of the plates and will also ensure that these fragile glass plates remain in an upright position as the collection is accessed by staff. Insert additional dividers or wedges to fill up extra space in a box or drawer.

Don't use traditional wooden grooved boxes for glass plate storage.

Cracked or broken glass plates should be duplicated to eliminate the need for further handling. Support them on their emulsion side with a clean, clear single-weight piece of high alumina silicate glass or non-textured Plexiglas of the same dimension. Protect the supported plate on both sides with four-ply neutral pH ragboard also cut to the size of the damaged negative. Then seal the sandwich at all edges with Filmoplast P-90 pressure-sensitive tape, and note the subject matter and condition on the ragboard support.

House glass plate negatives that exhibit active flaking or deteriorated binder layers and/or broken glass supports in custom-made neutral pH sink mat housings. Build these mats out of acid-free, single-walled corrugated board, laminated together with 3M 415 double-sided pressure-sensitive tape. Use neutral pH ragboard shims, attached to the back mat with 3M 415 tape to separate glass fragments to prevent abrasion along broken interfaces. Construct each sink mat with a hinged lid and be sure its height is sufficient so that its lid doesn't come in contact with the negative's surface. Standardize the outer dimensions of all sink mats.

In most cases mending isn't required and protective housing as described above should be sufficient. If mending is deemed necessary, ask a conservator to do it.

Finally, mark all folders and boxes containing glass clearly with the word "GLASS." Don't house boxes of glass plate negatives on upper or bottom shelves where they may be difficult to reach or lift.

9. *How do I house black-and-white negatives?*

Use three layers of protection when storing black-and-white negatives.

- Place each negative in a sleeve
- Place each sleeve in a box or drawer
- Place each box or drawer on a shelf or in a cabinet

House nitrate and acetate film-base materials in chemically stable buffered paper enclosures that meet ANSI IT9.2 specifications (see Section K). House sheet film negatives in four flap seamless enclosures or envelopes with a side, rather than central, seam. If envelopes are used, insert the negatives so that their emulsion surfaces face away from the seam.

Don't use plastic materials including mylar polyester for the storage of nitrate or deteriorated acetate negatives.

10. *Why do I place color photographic collections in cold storage?*

Cold storage is the only way to preserve color photographs in their original form for long periods of time. Therefore, with valuable color collections, be sure to use humidity-controlled cold storage for originals and copies for reference and duplication purposes.

Cold stored masters should be the original, regardless of process. Duplication and viewing copies should be available so that the original images don't need to be removed from cold storage. Each generation of copies loses some image detail and has some color shift. Avoid introducing a copy as the master, because subsequent copies are apt to be too distorted.

While all color photographic materials will benefit from cold storage, according to Henry Wilhelm there are specific color photographic processes for which cold storage is particularly imperative. These include pre-1984 Ektacolor, Fujicolor, Agfacolor, and Konica Color prints; all pre-1991 Kodak Ektachrome prints; color negative films, especially Ektacolor, Vericolor II, Kodacolor-X, and Kodacolor II; and color transparency films such as Process E-1, E-2, E-3, and E-4 Ektachrome films, ANSCO and GAF films.

The majority of color slides are one-of-a-kind transparencies produced by the reversal processing of chromogenic (Kodachrome and Ektachrome) film. No negative remains. The most important factors you need to consider in determining the useful life of color slides is their inherent dye stability and resistance to stain formation during aging. Improper processing of color materials can also adversely affect image stability.

The stability of color transparency film varies considerably. Kodachrome film, for example, is clearly the most stable transparency film in dark storage, yet it has the worst projector fading stability of any slide film currently available. E-6 Ektachrome film, in comparison, will develop high levels of yellow stain during dark storage but is more stable than Kodachrome when projected.

11. *How do I determine what is appropriate cold storage?*

You can create cold storage either by using a frost-free refrigerator or by constructing a cold storage facility. The latter option is significantly more costly and only appropriate for large collections of materials for which the use of refrigerator units isn't feasible.

12. *What do I need to know about storage in a frost-free refrigerator?*

Refrigerated storage is vital for the long-term preservation of pre-1984 Ektacolor, Fujicolor, Agfacolor, and Konica Color prints; all pre-1991 Kodak Ektachrome prints; color negative films including Ektacolor, Vericolor II, Kodacolor-X, and Kodacolor II; and color transparency films such as Process E-1, E-2, E-3, and E-4 Ektachrome films, ANSCO and GAF films.

A frost-free refrigerator will effectively slow the fading rates and greatly extend the life of color photographic materials. See *TOT* for specific makes and manufacturers. Operate these refrigerators in a well-ventilated room, but not in the museum storage room. They give off a considerable amount of heat. In the event of a power failure lasting longer than 48 hours, unplug the unit and leave the door open until the power is restored.

- ***Environmental Monitoring and Control***. Maintain refrigerators

properly. Monitor temperature and humidity levels at all times, ideally through the use of a datalogger drilled and attached to the refrigerator for external monitoring. Use conditioned silica canisters to help maintain the relative humidity. Place a separate thermometer in the refrigerator compartment where temperatures should be adjusted to 1.7°-4.4°C (35°-40°F).

- ***Fullness.*** Don't pack the refrigerator too tightly as constant air circulation is essential. You can use the vegetable and fruit storage drawers, but never place photographic collections directly on the bottom of the refrigerator compartment. Don't block the vent for forced cold air, and don't keep food and drink in the refrigerator.

- ***Housing.*** Package all color films and prints in envelopes and boxes and place them in polyethylene bags, such as heavy duty freezer Ziplock bags, or wrap them in polyethylene with all seams carefully sealed with freezer tape. Slide collections, packaged in paper or plastic boxes or slide pages, should also be sealed with polyethylene. This eliminates the need for pre-conditioning and prevents moisture condensation on the collection materials when the refrigerator door is opened or when they are removed and warmed to room temperature. Place moisture indicators inside the bags to help monitor environmental conditions.

  If it is unavoidable, then carefully seal all photographs in vapor proof enclosures such as heat-sealable, aluminum foil envelopes. In doing so, precondition these materials at a low (30%-40%) relative humidity. These kinds of storage systems come with a constant risk of improper seals and punctured enclosures, so they tend to reduce, and in some cases realistically eliminate, access to the collection.

- ***Preconditioning.*** Pre-condition valuable photographs by storing them for several days at a low relative humidity for maximum safety. Keep objects in the surrounding environment several hours while they reach equilibrium with the surrounding air. Then seal them in vapor-proof envelopes and place them in the refrigerator.

- ***Retrieval Guidelines.*** Develop proper collection retrieval guidelines in consultation with a conservator. Warm-up times will vary and are dependent upon the amount of materials being removed. Don't routinely retrieve collections from cold storage. Instead, use access and duplication copies for research access and copying.

  Allow a collection to warm up for 24 hours if you must retrieve it. During this time the collections should remain wrapped in polyethylene bags to prevent moisture condensation. Air should be allowed to circulate freely around the collections as they gradually warm to room temperature.

- ***Refrigerator Selection.*** If at all possible, don't use a freezer, or an older manual defrost or newer cycle defrost (energy saver) refrigerator. The unit should have separate refrigerator and freezer compartments. Both compartments must be guaranteed to be frost-free.

  – Cooling coils in the unit should be located only in the side of the

freezer section. No part of the refrigerator or freezer that

condenses moisture or forms ice crystals should be visible in the unit.

– Air should be forced over the cooling coils and into the freezer section by an internal fan.

– All cooling in the refrigerator section should come from cold air blown in from the freezer section by an internal fan.

13. *What do I need to know about storage in a cold storage vault?*

Because the design and construction of a cold storage vault for photographic materials requires specialized knowledge, you will need to select an experienced contractor and consult with curators, archivists, and conservators familiar with cold storage systems.

- ***Environment.*** For optimum protection, experts may recommend vault temperatures of -18°C (0°F) and relative humidity levels of 30%. These levels are difficult and expensive to maintain and aren't ideal in situations where collections are regularly accessed. For these reasons, many cold storage vaults in the United States are currently operating at 4.4°C (40°F) and 40% RH. Whatever the temperature, humidity cycling must be avoided in all cases.

  Equip your vault with redundant and independent environmental systems in the event of equipment failure. Install air filtration systems to remove acetic acid and oxidizing gases. Outside the storage, install automatic dry-desiccant dehumidifiers with high efficiency particulate air (HEPA) filters. All cold storage vaults should have automatic shutdown systems that will activate when deviations from pre-set limits of temperature and relative humidity occur.

- ***Housing***. Storage in a low temperature vault requires that the photographic materials be placed in acid-free boxes, portfolio cases, motion picture cans, and other enclosures safe for the long-term storage of photographs. Vapor-proof packaging isn't required.

- ***Retrieval.*** You also need to be aware that regular and constant retrieval of materials from cold vaults will directly affect their projected life expectancy. Heavily accessed materials may not benefit as significantly from storage in low temperature vaults—below -9.5°C (15°F). Therefore, be sure to make use and duplication copies of rare or fragile materials ***before*** placing the items in cold storage, so that the originals can fully benefit from cold storage and be preserved for a maximum lifetime.

  Place packages removed from the vault in polyethylene bags and allow them to warm up gradually. Small packages, such as a single matted color print, should have very short warm-up times and should be available for use almost immediately upon removal from cold storage.

14. *When can I remove original photographic materials from cold storage?*

Don't remove originals from cold storage except in three cases:

- power outages of longer than 48 hours
- visits by photographic researchers who are studying details of process, format, and image manipulation
- the need to replace a damaged, deteriorated, or lost copy negative

15. *How do I house color slide collections?*

Color slides not in cold storage, such as those that may be heavily used, should be enclosed in individual polypropylene or triacetate sleeves, unless kept in permanent or inactive storage. These sleeves should fit tightly around each slide so that the slides won't fall out. These sleeves aren't necessary for glass-mounted slides because glass mounts offer protection from fingerprints and scratches. Glass mounts don't reduce the rate of fading associated with dark or light storage.

You can also house slide collections in polypropylene slide pages, available in several gauges. (These pages may be used in conjunction with individual acetate sleeves.) The heavier gauge (5.0) is recommended for its superior handling characteristics. Rigid, open frame polypropylene Saf-T-Stor slide pages supplied by Franklin Distributors Corporation are also recommended. Avoid polyvinyl chloride (PVC) pages as well as low density polyethylene. Polyethylene's physical strength is inadequate and the presence of anti-block and slip agents that have been incorporated during manufacture may promote ferrotyping of the slide surfaces.

You can house large slide collections in acid-free boxes fitted with movable interior dividers or in baked-on enamel or powder-coated cabinets, but be sure that non-glass mounted slides are carefully protected from handling.

G. Preventive Conservation: Exhibiting Photographic Collections

1. *How do I exhibit photographic prints?*

The recommended environmental conditions for the exhibition of photographic print materials are identical to those for storage: 30%-50% RH and 20°C (68°F). Never exhibit photographic prints for more than four months per year.

Never place original photographic print materials on permanent display. Consider exhibiting facsimiles or copy prints where the use of original prints isn't essential.

Restrict illumination, either artificial or natural, for display of most nineteenth century photographic print materials to 50 lux (5 footcandles). This standard applies to all photographic materials which have exposed paper fibers, such as salted paper, platinum, and cyanotype; photomechanical processes, such as collotype and photogravure; and albumen photographs. Fifty lux (5 footcandles) also is recommended for photographic prints that have applied color such as hand tinting and/or tinted binder/baryta layers. Prints with untinted baryta layers, most

silver gelatin and collodion-chloride processes, may tolerate up to 100 lux (10 footcandles) exposure.

Never expose photographic materials to direct sunlight or ultraviolet radiation. If possible, use tungsten (incandescent) or fibre optic illumination instead. Incorporate filters and diffusers with all case lighting.

It's also a good practice to monitor the condition of photographic prints at frequent intervals while they are on display. Photochemical damage is usually most apparent as a difference in appearance between exposed print areas and those protected by the window mat. You can find procedures for monitoring print materials in Section K.

All framed photographs you select for exhibition should be paper hinged or photocornered into 100% neutral pH ragboard mats and glazed with ultraviolet filtering acrylic sheeting (Plexiglas). *Only* latex paints should be used to prepare walls and exhibition spaces, since the peroxides emitted during the curing of oil-base paints will accelerate silver image deterioration.

Finally, have a conservator stabilize any photographs that exhibit serious deterioration problems before exhibiting them. See *MH-I*, Chapter 8, Conservation Treatment, for guidance on conservation treatment.

2. *How do I exhibit daguerreotypes, ambrotypes, and tintypes: cased and uncased formats?*

A cased object consists of the photographic image, decorative brass mat, and cover glass. These components are usually sealed with paper tape and flexible brass preserver. The photographic images themselves aren't particularly light sensitive (for example, a daguerreotype plate won't fade upon exposure to light). However, the dyed decorative fabrics, paper, and leather integral to case construction, as well as some of the pigments used in hand coloring, are very susceptible to fading. Natural resin varnish layers on tintype and ambrotype surfaces may yellow upon exposure to light.

Exhibit cased objects within closed display cases at low light levels (50 lux or 5 footcandles) for limited periods of time.

You also should maintain stable temperature and relative humidity levels within these cases. A sudden rise in temperature may cause an ambrotype's black lacquer backing to irreversibly crack and craze or a daguerreotype's gilded surface to exfoliate.

3. *How do I exhibit color photographic collections?*

All color prints, with the exception of Ultrastable Permanent Color, will fade when exposed to light during exhibition. Different types fade differently with some lasting significantly longer than others. Never subject valuable or non-replaceable color prints to prolonged (more than one week) display. Use copies instead.

For most color print materials the spectral distribution of the illumination source, for example, incandescent versus fluorescent, has relatively little effect on their fading rates. In fact, it is the intensity of illumination that is important.

Keep illumination levels low: 50 to 100 lux (5 to 10 footcandles) are frequently recommended for the exhibition of color photographic material. Also, be sure to monitor prints with a reflection densitometer prior to and

following exhibition, in order to have a qualitative record of a print's original condition and the complex changes that may take place following exhibition. Consult a photograph conservator for procedural guidelines to ensure that prints aren't damaged during the monitoring process and that the results are valid.

Color images deteriorate due to inherent instability of organic dyes. Wilhelm (previously cited) identifies and categorizes these unique deterioration characteristics. The characteristics pertaining to exhibited collections are as follows:

- Fading caused by exposure to light and ultraviolet radiation during display or projection. The rate of light fading is a function of the intensity of illumination and the duration of exposure. The rate of fading is also specific to each type of color film and print material. Most Kodak Ektacolor RC prints made between 1968-1977 and displayed for extended periods of time, for example, now exhibit severe image fading and color balance shift.

  The light fading characteristics of modern materials vary considerably. Most modern chromogenic color print materials have an ultraviolet-absorbing coating and, therefore, UV radiation isn't considered to be a major contributing factor to the light degradation of these materials. Most of the fading that occurs with these papers is caused by exposure to visible light. Ilford, Ilfochrome and Kodak Dye Transfer prints don't have UV-absorbing coating. These materials will be quickly and irreversibly damaged by exposure to ultraviolet radiation. Ektachrome slide film is more stable than Kodachrome when the processes experience regular exposure to light.

  In general, you should carefully restrict the exhibition of original color photographic prints and, where acceptable, substitute facsimile copy prints for long-term display.

- Light-induced yellow stain formation. For most modern color materials light-induced staining is a relatively minor problem when compared with the irreversible fading of cyan, magenta, and yellow dye layers.

H. Preventive Conservation: Inspecting Photographic Collections

1. *What is the Condition Checklist for Visual Images?*

The Condition Checklist for Visual Images provides a simple way for conservators or park curators who are familiar with visual images and their conditions to record the overall condition of an image, group of images, or collection, as well as the control numbers, location within a specific collection, physical process, format, and techniques, and specific deterioration conditions.

2. *How do I use this checklist?*

The form can be used to record this information for: a single image (for example, negative 5, of folder 9, of box 3, of collection X); a group of images (for example, negatives 43-97, of boxes 1-2, of collection X); an entire collection (for example, negatives 1-2000, of boxes 1-20, of collection X). When using the form for more than one image, check all categories that apply for that group of materials. You may need more specific data for planning purposes, such as the estimation of the amount of treatment work needed or rehousing needs. In such cases, use specific numbers to indicate the quantities of images that exhibit a specific trait (for example, brittleness 10 indicates that 10 images exhibit brittleness in the materials being evaluated).

3. *Where do I find the checklist?*

See Figures R.3a and R.3b for the checklist. An unpunched full size checklist accompanies this appendix. Keep the full size checklist as a master and make copies for your use.

I. Conservation Treatment Issues for Deteriorated Photographic Materials

1. *What does this section cover?*

This section describes appropriate treatments for different kinds of deteriorated photographic print materials in order to give you a sense of what will need to be done. In some cases, no treatment may be appropriate. In all cases, have a conservator treat these materials.

2. *Why use a conservator?*

In devising a valid treatment proposal, a conservator will evaluate the physical condition and chemical composition of all components that may be incorporated into these photographic materials, including the secondary support and its method of attachment, as well as the presence of hand coloring, retouching, and/or additional varnish layers. Historic and contemporary photographic materials are composed of a wide variety of organic and inorganic compounds, synthesized into a complex, multi-layered structure. The conservator will:

- consider potential reactions and interactions of these materials to proposed conservation treatment procedures.
- evaluate the photograph's historic and aesthetic integrity as well as the short- and long-term risks and merits of a particular treatment procedure
- identify the purpose (exhibition versus storage) and scope (single item versus large group) of a particular treatment in order to determine the nature and extent of possible reconstruction or restoration
- propose a viable treatment procedure to the curator that is based on all of these critical factors

3. *What are the ethical considerations?*

An accurate discussion of current conservation treatment practice should include an acknowledgement and understanding of the ethical principles

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Condition Checklist For Visual Images

Control Numbers:

Accession number(s) _____
Catalog number(s) _____
Item number(s) _____

Negative number(s) _____
Collection Name: _____

Location(s) of the Item(s) in the Collection:

Box number(s) _____
Folder number(s) _____
Item sequence number _____
Other number _____

Photographer(s): _____

Dates: _____

Physical Description:

Process(es) _____
Format(s) _____
Size(s) _____

☐ Color ☐ Monochrome
☐ Negative Transparency ☐ Print(s)
☐ Positive Transparency ☐ Drymounted
☐ Matted ☐ Framed ☐ Cased ☐ In Album
☐ Autographed ☐ Other

General Condition Analysis:

☐ Excellent ☐ Good ☐ Fair ☐ Poor

Specific Condition Analysis: (Check all that apply and indicate approximate quantities or percentages when dealing with large quantities)

a. Primary Support/Secondary Support:

☐ Brittleness _____ ☐ Tack holes/punctures _____
☐ High acidity _____ ☐ Adhesives _____
☐ Lignin content _____ ☐ Tapes _____
☐ Cockling/buckling _____ ☐ Discoloration _____
☐ Curling _____ ☐ Waterstains _____
☐ Folds/creases _____ ☐ Matburn _____
☐ Wrinkles _____ ☐ Foxing _____
☐ Warp ☐ Mold _____
☐ Tears ☐ Insect/vermin accretions _____
☐ Losses _____ ☐ Dirt/grime _____
☐ Holes ☐ Fingerprints _____

Figure R.3a. Condition Checklist for Visual Images (Sample)

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Condition Checklist For Visual Images

b. Image Layer/Media:

- ☐ Fading _____
- ☐ Color shift _____
- ☐ Discoloration _____
- ☐ Water stains _____
- ☐ Oleaginous stain _____
- ☐ Silver sulfiding or tarnishing _____
- ☐ Loss of highlight detail _____
- ☐ Loss of dense detail _____
- ☐ Loss of surface gloss _____
- ☐ Emulsion flaking _____
- ☐ Applied color flaking _____
- ☐ Bleeding/feathering of applied color _____
- ☐ Surface cracking/crazing _____
- ☐ Surface abrasion _____
- ☐ Embrittlement _____
- ☐ Media stuck to another object _____
- ☐ Emulsion softening _____
- ☐ Emulsion powdering _____
- ☐ Cockling/buckling _____
- ☐ Channeling _____
- ☐ Dimpling _____
- ☐ Emulsion bubbling or flow _____
- ☐ Binder migration _____
- ☐ Trim _____
- ☐ Cut _____
- ☐ Tears _____
- ☐ Losses _____
- ☐ Holes _____
- ☐ Adhesives _____
- ☐ Cloth tapes _____
- ☐ Plastic tapes _____
- ☐ Dirt/grime _____
- ☐ Dust _____
- ☐ Smoke damage _____
- ☐ Fingerprints _____
- ☐ Insect grazing _____
- ☐ Mouse chew _____
- ☐ Insect or vermin accretions _____
- ☐ Mold _____
- ☐ Foxing _____
- ☐ Other (Describe) _____

Additional Comments:

Figure R.3b. Condition Checklist for Visual Images (Sample)

and standard guidelines that conservators follow. All conservators are bound by a Code of Ethics. See *MH-I*, Chapter 8, Conservation Treatment, and Appendix D, Code of Ethics, for a detailed discussion of conservation treatment and the Conservator's Code of Ethics. These codes address the critical issues of treatment practice, such as:

- In the treatment of photographic materials, all actions must be governed by respect for the integrity of the photograph including its physical, historical, aesthetic, and cultural significance. The conservator must adhere to the highest and most exacting standards.

- The conservator must restore deteriorating materials according to an understanding with the owner, custodian and, in some cases, the photographer, if living. Conservation treatment must not modify or conceal the true nature of the object. It must be detectable, although it need not be conspicuous, and must be fully documented. A conservator must use appropriate materials and techniques that will have the least adverse effects and that can be removed most easily and completely. Conservation treatment procedures must not impede future examination or treatment possibilities.

4. *What treatments will the conservator use?*

While many of the conservation treatments discussed apply to both nineteenth- and twentieth-century photographs, they do *not* apply to contemporary color materials. The complexity of modern color materials eliminates most treatment options.

> ***It is important that these treatments be carried out by a conservator who specializes in photographic materials. Improperly done, these treatments will cause irreversible and catastrophic damage.***

Practical, reversible, and predictable conservation treatment procedures for deteriorated photographic print materials are continually being developed and refined. However, many questions remain unanswered. Many objects are left untreated as informed conservators advocate restricted handling and stringent environmental control for the preservation of particularly fragile materials for which treatment isn't, at this time, an option.

- ***Removal of Microorganisms***

  The organic constituents of photographic materials are vulnerable to microbiological attack associated with upper extremes of temperature and relative humidity. The most effective treatment in all but the most severe cases is modification of the environment and removal of the mold growth from the affected item by using a vacuum aspirator or tweezers.

  Mold removal may yield a fragile and disfigured surface, requiring careful consolidation and inpainting by a conservator. Primarily because of their potential toxicity and chemical reactivity, the use of fungicides or fumigants in the treatment of mold-damaged photographic materials has been curtailed radically. See *COG* 3/4, Mold and Mildew: Prevention of Microorganism Growth in Museum Collections, for guidance on monitoring and controlling the environment to prevent microorganism growth in collections.

- ***Consolidation of Flaking Binder Layers***

  In some cases, photographic images will exhibit moderate to severe flaking of their binder layer, thus requiring immediate consolidation by a conservator. (Consolidation is the application of an adhesive to improve cohesion between a deteriorated binder layer and its substrate.)

  Consolidation techniques also may incorporate the use of aqueous or non-aqueous solutions, the choice of which is typically dependent on the physical and chemical compatibility of the consolidant and its selected solvent with the deteriorated binder layer. The use of solvent-soluble adhesives such as acrylic resins, for example, may not be appropriate for the consolidation of a deteriorated collodion binder layer. Likewise, the high pH of acrylic dispersions, often ranging from 8.0 to 9.0, may prove problematic for use with proteinaceous binders. The conservator will also need to evaluate any additional properties, such as long- and short-term reversibility, flexibility, adhesive strength, chemical reactivity, and the possibility for irreversible visual alteration.

- ***Reduction of Surface Dirt***

  Photographic images exhibiting embedded dirt and grime may be carefully surface cleaned after a conservator has thoroughly evaluated the possibility for physical or chemical damage, as well as permanent alteration in surface reflectance or gloss. Conservators employ a variety of materials and techniques in an attempt to reduce dirt and grime layers effectively from photographic surfaces. These include soft brushes, non-sulphur-containing crumbled vinyl erasers, distilled water and organic solvent solutions applied with cotton swabs and/or balls.

  Severe structural damage to a binder layer may prevent dirt removal. This is often true of deteriorated albumen photographs, in which the egg white binder is severely cracked and crazed. The conservator must be extremely careful when cleaning photographs in which the final image material is embedded in the paper support, such as salted paper or platinum prints, as these images are abraded easily.

  On film-based negatives and transparencies and slides, park staff may use compressed air available in aerosol cans (for example, Dust-Off, Omit) to reduce surface dirt. This procedure should be performed under the guidance of a conservator and only on film in good condition with no evidence of physical damage. Some aerosol-canned products contain oily gray substances. Test first by spraying on a white blotter.

  Photographic materials that have accumulated a lot of surface dirt and dust may require immediate attention by a conservator, who will safely remove superficial loosely attached dirt with a dry, soft brush.

- ***Removal of Tapes and Adhesives***

  In order to safely remove paper hinges, residual adhesives, and pressure-sensitive tapes from a photograph's surface, a conservator may use direct or indirect moisture vapor, methyl cellulose poultices, aqueous solutions, organic solvents, and many other accepted paper conservation techniques.

- ***Removal of Poor-Quality Secondary Supports***

  The vast majority of historic photographic prints were mounted during manufacture, with mounts usually consisting of a poor-quality lignin-core board sandwiched between two thin, high-quality papers. Lignin decomposition products may react with proteinaceous materials such as albumen or gelatin, producing a highly colored compound and/or emitting oxidants such as peroxides and causing silver and dye image materials to fade and discolor. In addition, these secondary supports are often acidic and embrittled, posing serious structural danger to the photographs themselves. If this is the case, use extreme care in handling these fragile materials, and consider conservation treatment.

  If undertaking treatments of this type, the conservator will consider the historic and aesthetic integrity of the photograph’s secondary support. Through careful visual and microscopic examination, the conservator will evaluate the possible deleterious effects associated with the mounted photograph's adhesive and secondary support material, as well as the sensitivity of the photograph's component structure to possible physical or chemical damage during treatment.

  Typical backing removal techniques involve mechanical removal, the local application of moisture vapor or steam, and/or immersion in aqueous or organic solutions. Treatment choice will be dictated by the photograph's structural and chemical condition. Inadequately hardened gelatin prints, for example, may swell dangerously when exposed to moisture. Exposure to moisture via surface cleaning, humidification or immersion will likely cause albumen binder layers to crack and craze, with a resultant loss of surface gloss. Many albumen and silver gelatin photographic prints, therefore, may require absolutely dry techniques, such as the use of metal or Teflon spatulas, for the safe removal of their deteriorated secondary supports.

- ***Humidification and Flattening***

  Humidification and flattening of rolled, cockled or warped photographic prints are critical operations that, if done incorrectly, may induce dimensional instability, irreversible damage to a binder layer, and/or irreversible staining in the photograph's primary support. However, a conservator can develop treatment strategies for the humidification and flattening of curled photographic prints and, in some cases, park staff can be trained to carry out these procedures as well.

- ***Chemical Treatment***

  An issue of considerable importance and active debate in the photograph conservation field today is the use of chemical treatment. The dire consequences of ill-advised treatments can't be ignored. For this reason, most practicing conservators agree that many chemical treatments, such as the bleach and redevelopment of faded silver images, particularly on fine art photographs, require more research before use.

- ***Structural Repair***

  Photographic prints exhibiting creases, tears, losses, and other structural damages may be mended by a conservator utilizing accepted paper conservation techniques. In most cases, the conservator can mend tears successfully by using the appropriate weight Japanese paper combined with wheat starch, gelatin, or methyl cellulose adhesive.

- ***Remounting of Photographic Prints***

  Photographic prints that have been removed from their mounts during treatment may require lining or remounting in an attempt to stabilize, consolidate, strengthen, and facilitate handling for exhibition and/or storage.

  In selecting the appropriate mounting technique, the conservator will consider a variety of factors pertaining to the photograph's condition and appearance prior to and following mounting. The conservator must take into account the potential for cracking or crazing of an albumen binder layer, for example due to the expansion and contraction of a wet secondary support. This may occur in many currently practiced remounting techniques.

  Methods used by conservators to remount photographic prints include:

  – line unmounted photographs directly onto Japanese papers or rag papers and boards using methyl cellulose or wheat starch adhesives

  – line a humidified photograph with Japanese paper and wheat starch paste onto a sheet of unbuffered two- or four-ply ragboard that has been counterlined on the reverse to minimize warpage

  – adhere the unmounted photograph onto a smooth-surfaced rag paper with wheat starch or methyl cellulose adhesive

    The polyester fabric or "Dacron," which is then pasted onto sanded Plexiglas, acts to hold the photograph's secondary support under tension and is removed following drying.

  The latter technique may be particularly suitable for the mounting of larger collections or holdings of photographic prints, as the cost of materials and time requirements can be minimized.

Each of these mounting techniques has distinct advantages and disadvantages. Discuss the ramifications associated with each of these options with your conservator.

- ***Compensation of Losses***

  Following remounting, a conservator may inpaint abrasions, scratches, tear edges, and other disfiguring damage in a photograph's surface by using a variety of media, including watercolors, ground pigments in acrylic resins, and pastel pencils. In all instances, the conservator will first evaluate the long-term aging characteristics of the selected media and their "compatibility" with the damaged photograph in terms of chemical reactivity, solubility parameters, and surface qualities. The extent of compensation should also be discussed and agreed upon in collaboration with the curator or collection manager.

J. The Recovery of Water-Damaged Photographic Materials

See *MH-I*, Chapter 10, Museum Collections: Emergency Planning for guidance on emergency planning, and to Chapter 8, Conservation Treatment, for general rules on appropriate response to emergency situations involving museum objects.

1. *How should I recover water-damaged materials?*

If at all possible, water-soaked photographic materials should be air-dried, laid flat on a clean surface or hung on a line with clips that won't leave indentations (not binder clips). If you can't air-dry these materials, due to lack of personnel, facilities, and/or time, freeze them and then thaw and air-dry them later. Don't freeze glass plates or lantern slides.

Vacuum freeze-drying is the next preferable alternative. In this system place the photographs in a vacuum chamber either wet or frozen. The vacuum is pulled, a source of heat introduced, and the photographs, which dry at temperatures below 0°C (32°F), remain frozen until dried. Vacuum freeze-drying may result in a significant loss of gloss and/or a strong tendency to curl. The tendency to curl may be overcome by careful humidification following freeze-drying. In all cases, *avoid vacuum thermal-drying* whereby photographic materials are dried at temperatures above 0°C (32°F). As a result, photographic binder layers will have a strong tendency to block or stick together irreversibly. Don't vacuum freeze dry glass plates or lantern slides.

If photographs have been immersed in dirty water, a disaster recovery team should carefully wash them in changes of cold, preferably distilled, water prior to air-drying or freezing. Carefully monitor the condition of the photographs to ensure that binder layers or original ink annotation on mounts aren't being damaged. Some color processes may require bathing in a stabilizer prior to air-drying. Consult a conservator.

2. *What should I salvage first?*

In general, black-and-white photographic prints appear to be more resistant to water damage than contemporary color materials. Photographic film-base negatives are more resistant to deterioration than print materials. Depending upon the collection priority, you may want to salvage color

materials first.

Mold grows after 48 hours above 65% RH and 21°C (70°F). Emulsions soften and stick if not separated during the drying process. During salvage, rescue the following first: silver gelatin processes (prints, negatives, and transparencies), glass plates, lantern slides, ambrotypes, daguerreotypes, color materials and acetate and nitrate film base. Albumen processes, collodion prints, salted paper prints, cyanotypes, and platinum prints can be done last.

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Photographic Processes: Standards

American National Standards Institute. (See following list of standards)
ANSI/NAPM IT9.1-1992 (Silver Gelatin Imaging Stability)
ANSI IT9.2-1991 (Enclosures and Containers)
ANSI IT9.6-1991 (Safety Film Stability)
ANSI IT9.11-1991 (Safety Film Storage)
ANSI/NAPM IT9.11-1993 (Storage of Photographic Film)
ANSI/NAPM IT9.16-1993 (Photographic Activity Test)
ANSI IT9.20-1994 (Storage of Photographic Prints)
ANSI/NAPM IT9.18-1994 (Storage of Photographic Plates)
ANSI PH1.51-1990 (Photo & Micrographic Film Dimensions)
ANSI/ASC OG4.8-1985 (Residual Thiosulfate)

These items are available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036, 212-642-4900; or from the Association for Information and Image Management, 1100 Wayne Avenue, Suite 1100, Silver Spring, MD 20910, 301-587-8202.