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ABSTRACT

This is the fifth booklet in the U.S. Department of Commerce Consumer Information Series. Paper, its composition, types, and preservation are discussed, as well as enemies of books, i.e., heat, humidity, light, air pollutants, and insects. Instructions are given for minor repairs on books and paper, and suggestions for the care of photographic films, negatives, slides, and prints. A bibliography is included. (JAB)

Care of Books, Documents, Prints and Films

IN THE MID-1940'S, experts recognized that the Declaration of Independence and the Constitution of the United States were being subtly destroyed by the combined actions of light, atmospheric gases, and changes in temperature and humidity. In 1950, to stop the deterioration, the National Bureau of Standards, in cooperation with Libbey-Owens-Ford and the Library of Congress, devised a method which seals and preserves these vital documents for posterity, yet permits them to be viewed at the National Archives as shown in the photograph above.

The sealing procedure involves the use of special glass to filter out harmful radiation, a chemically inert helium atmosphere, carefully controlled temperature and humidity, a special back-up paper to strengthen the weakened documents, and a built-in test cell which continuously monitors the enclosed protective environment.

In all likelihood you will never go to such lengths to preserve your books and documents, but the challenge is the same: to provide an environment which will protect them from their enemies, and preserve them for future use and enjoyment.

Care of Books, Documents, Prints and Films

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NBS CONSUMER INFORMATION SERIES 5
Editor: James E. Payne

Issued December 1971

A Consumer's GUIDE

FROM THE NATIONAL BUREAU OF STANDARDS
U.S. DEPARTMENT OF COMMERCE

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary
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NATIONAL BUREAU OF STANDARDS
Lewis M. Branscomb, Director

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FOREWORD

Technology is changing not only the products you buy, but the marketplace as well. Products are constantly being improved, and we accept rapid obsolescence of most products as part of the price we pay for improvement — new materials, new designs, new higher levels of performance.

But even in this age of rapid change, there are some of our possessions we want to preserve. The heirlooms, the antiques, and personal mementoes of past experience have value to us because they are irreplaceable.

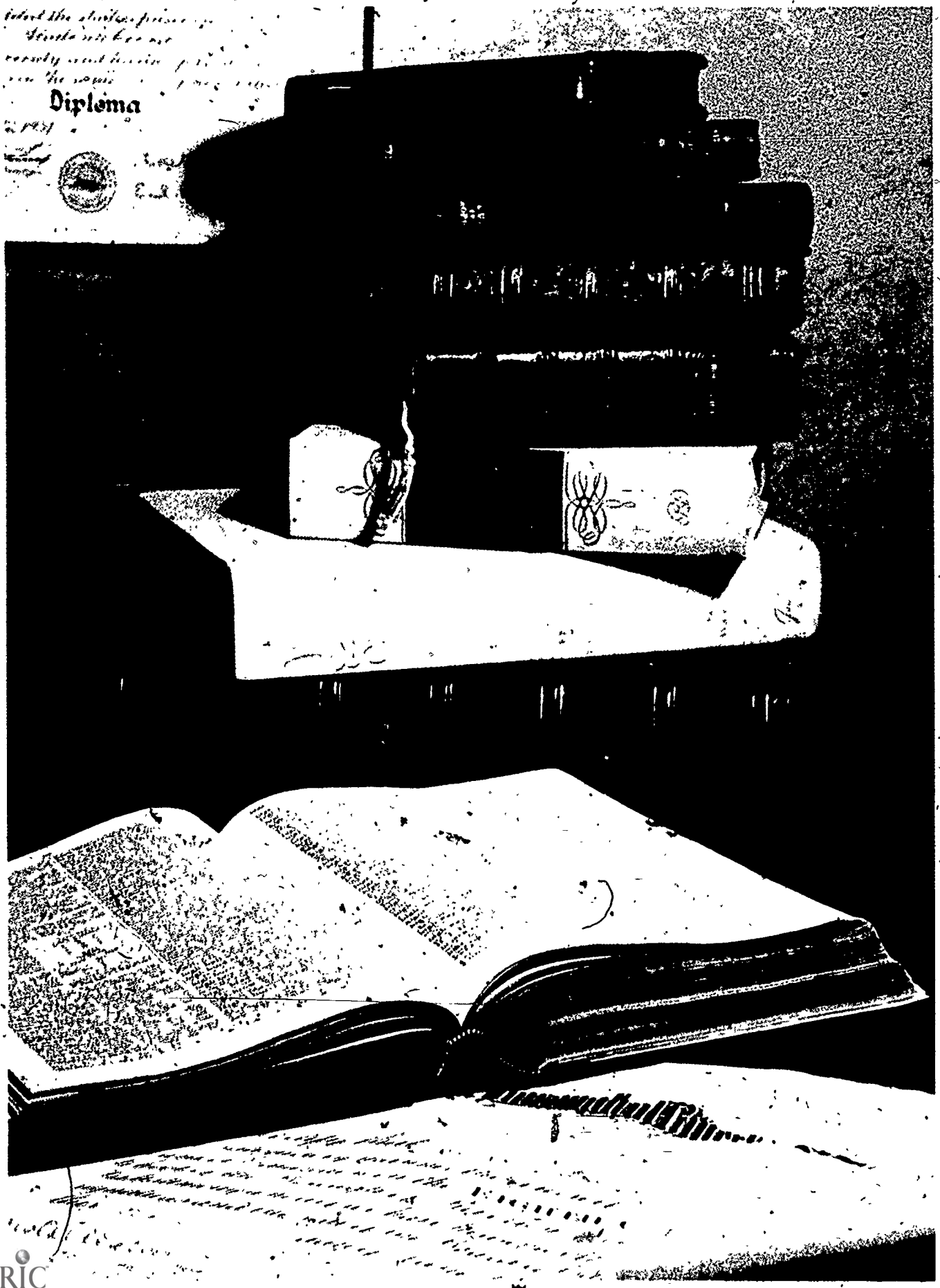
In the average household, books, documents and films often have this unique value. Letters, wills, contracts, manuscripts; books with a real or sentimental value; films that record family recollections — all are subject to deterioration and decay if they are not properly cared for.

The National Bureau of Standards has learned a lot about this problem in the course of its research and assistance to other agencies over the years. Probably the high point of this work in the preservation of documents was the sealing of the Declaration of Independence and the Constitution of the United States. While your documents may not be that valuable, they are important to you.

In CARE OF BOOKS, DOCUMENTS, PRINTS AND FILMS, the fifth booklet in our Consumer Information Series, we have asked our experts to share with you what they have learned about how to prolong the life of these family treasures with a minimum of trouble and expense.

At the request of the President and the Secretary of Commerce, we are pleased to make this information available to you.

Lewis M. Branscomb, Director


Diploma

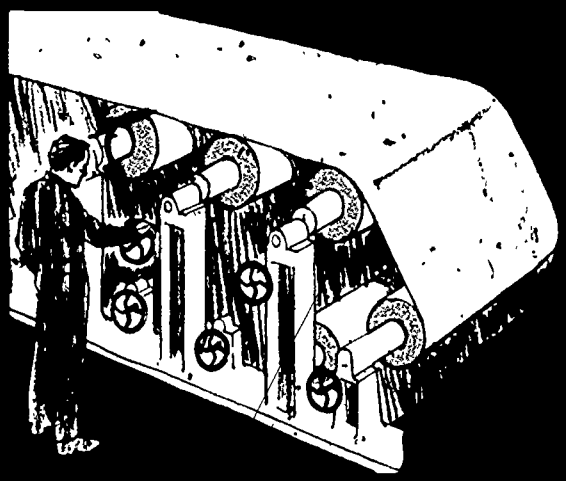
INTRODUCTION

If you own even a small collection of books which you treasure; if you have a box or a drawer full of documents which are valuable for financial or sentimental reasons; or if you have a collection of photographic films, this booklet should be useful to you. It tells you what you can do—and what you should **not** do—to care for these easily damaged possessions.

Many valuable documents have suffered irreparable harm from treatment performed by well intentioned but unskilled persons who were not familiar with the peculiarities of the material. One example is the photographer who offered to copy a parchment document for a friend. Since the document was wrinkled, the photographer dampened it with water and applied heat to speed up the drying. The result was a document permanently shrunk to half its original size.

CARE OF BOOKS, DOCUMENTS, PRINTS, AND FILMS is based in large part on research conducted by the Paper Evaluation and Photographic Sections of the National Bureau of Standards, Department of Commerce; and on the knowledge and experience of the National Archives and Records Service, General Services Administration, which supported much of that research. Sources in industry have been tapped for additional information. A short bibliography is included.

Paper



Composition of Paper

Paper can be made from many kinds of fibers. In the United States most papers are made from wood pulp, or, to a much lesser extent, from cotton or linen. Paper may also be made from sugar cane bagasse, certain grasses, straw, bamboo, and other fibers.

The key substance common to all of these materials is cellulose. It is a "polymer," a substance whose molecules are arranged in long chains like paper clips hooked together.

Cotton is almost pure cellulose. Wood is about 70 percent cellulose and similar polymeric materials, and about 30 percent lignin. Cellulose fibers supply most of the strength in wood; lignin is the cementing material that binds the cellulose fibers together.

Before wood can be made into paper it first must be converted into pulp. "Mechanical wood pulp" is made by reducing wood to fibers by grinding. "Chemical wood pulp" is made by isolating pulp fibers from lignin by chemical action.

Since lignin discolors badly upon exposure to light, wood pulp must be completely delignified before it can be used for making high-quality papers. Most of the lignin is removed by cooking, usually under pressure, by the sulfite or sulfate process. The remainder is removed by the use of bleaching agents.

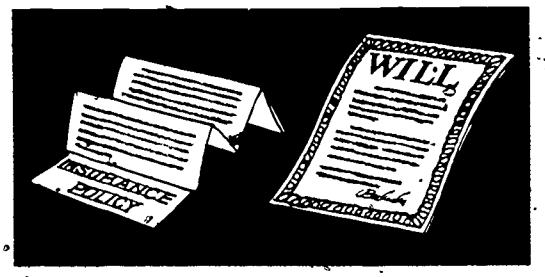
In making paper, the raw material (cotton or linen rag, wood pulp, etc.) is first broken down into fibers, then agitated mechanically in a water suspension and formed into a sheet by removing the water on an endless moving wire screen. Afterward, the sheet is dried on steam-heated cylinders.

Most papers contain a "sizing" (water repelling) material such as rosin, starch, glue, or synthetic resin to improve their writing or printing qualities. Papermaker's alum (aluminum sulfate) usually is added before the sheet is formed to fix the rosin or other sizing material on the fibers and to help retain pigment fillers in the paper. Although alum is very useful in the manufacture of most papers, and indispensable in some, it increases the acidity of the paper and thereby shortens its life.

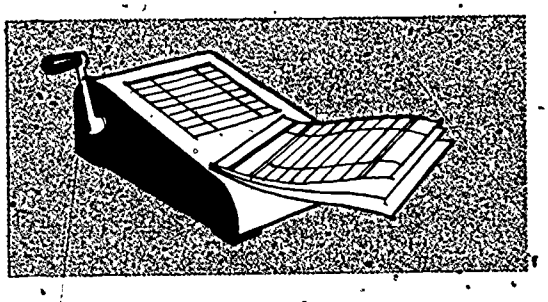
Kinds of Paper

Special papers are made for a variety of purposes. Some of the more common types are described below.

Bond was originally produced for uses where strength and durability were required for such documents as government bonds, securities, wills, and insurance policies. It is now used to meet more general needs, such as letterheads and forms. It usually is sized with a finish suitable for writing with pen or typewriter.



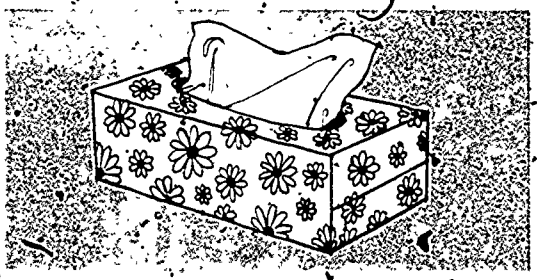
Manifold is a term applied to thin paper that is used for multiple-copy forms work, especially for carbon copies.



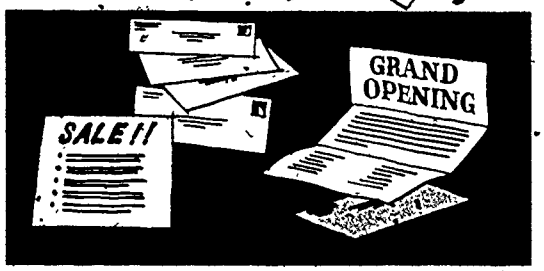
Coated paper is produced by the addition of a mineral coating (usually clay) in an adhesive mixture to the surface, making it smooth and capable of taking a high finish. Coated papers are used chiefly for printing.

Newsprint consists of about 75 percent mechanical wood pulp and 25 percent chemical wood pulp. Chemical wood pulp, which has comparatively long fibers, adds strength to the paper.

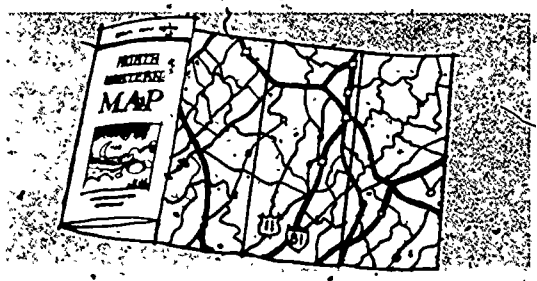
Tissue paper is thin, soft, transparent, and usually unsized. It is used for wrapping and protective purposes. Some high-quality tissue is used in the repair of paper records.



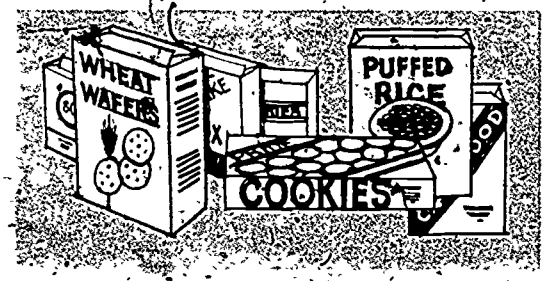
Offset is a well-sized paper used in the offset printing process. Good dimensional stability and high surface strength are its most important characteristics.



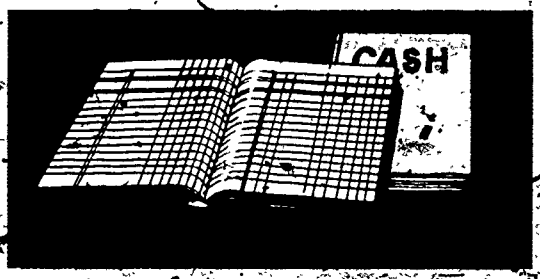
Map paper is a special kind of offset paper. It must be strong, pliable, resistant to wear and folding, and have good dimensional stability. The finish is generally smooth, without gloss.



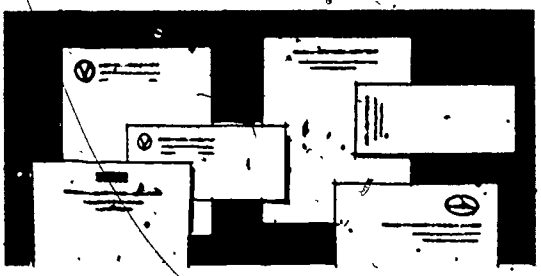
Parchmentized paper may be made by soaking paper in sulphuric acid, or by extensive mechanical treatment of the pulp before forming the sheet. It is used principally in the food industry.



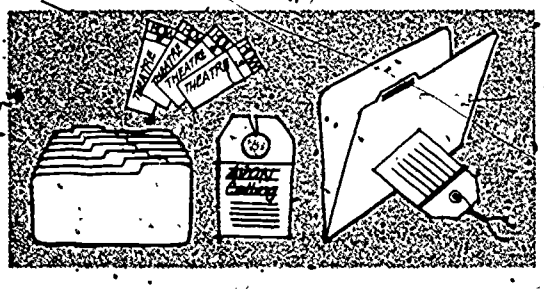
Ledger is a strong, durable paper similar to bond but heavier in weight, and usually heavily sized. It is used for deeds, legal forms, account books, court records, etc.



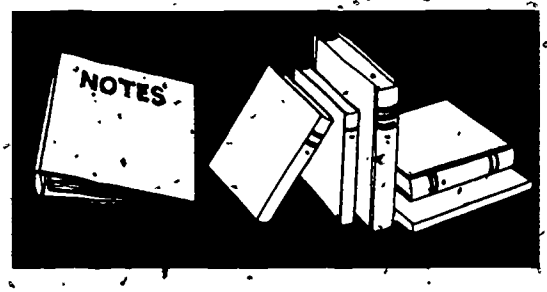
Laid papers, when held to the light, show a ladder-like pattern of parallel lines that are more transparent than the rest of the paper. Laid papers generally are intended to simulate more expensive hand-made papers.



Manila formerly was a term applied to a strong paper made of old manila rope or bags. Today the name has no significance with respect to composition; and manila paper may be made from many different pulps. One of its chief uses is for file folders.



The term **book paper** is used to define a group of papers that, in general, are most suitable for the graphic arts. These papers cover a wide spectrum of thickness, strength, finish, sizing, color, and composition.



Preservation Starts with Good Paper

The preservation of paper records is a matter of both "heredity" and "environment." With proper care a *good* paper may last for centuries, but it can go to pieces in a few years, or even in a few weeks, when exposed to physical abuse or improper storage conditions. On the other hand, a poor paper may survive a century or more under ideal storage conditions.

What is a "good paper"? The definition is elusive, for it depends on many related variables. The most important single variable is acidity. A stable paper contains very little acid; indeed, the most stable papers contain an alkaline filler, such as calcium carbonate or magnesium carbonate. If the book or document receives frequent handling, it should have good durability, which is related to the strength of the paper and the type of fiber.

Newsprint, from which no lignin has been removed, and papers from which only part of the lignin has been removed, often are not as stable as completely delignified papers. Such papers are readily discolored by light. On the other hand, newsprint is relatively stable when it contains no acid and is protected from light. Both delignified wood pulp papers and rag papers may cover the complete spectrum of stability.

Books

Bookbinding requires great skill and care. After the pages are printed, the binding process can be divided into four stages. A general understanding of these steps will help you care for your books and prolong their life.

Preparing the Signatures

The proper sequence of printed pages folded from a single printed sheet is known as a "signature" and is the foundation of the book. It is folded, cut, and squared to uniform size. The fold provides the foundation for sewing.

Sewing

Each signature of a book is sewed to tapes or cords which run at right angles across the back of the book.

Gluing

A strip of cloth is then glued to the backs of the sewed signatures.

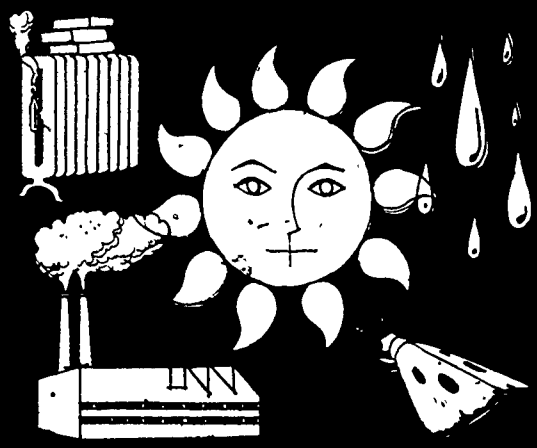
Covering and Finishing

A stiff cover board is attached to each side of the sewed and glued signatures. The boards are then covered with cloth or leather on the outside and finished off with a special cover paper on the inside. Old books, and modern hand-bound books, have the cords or tapes laced into the covers to make a stronger binding.

Today, many books—especially paperbacks—are "bound" with adhesives. This process is usually associated with inexpensive books, but there is no reason why high-quality materials and good workmanship cannot produce a quality product. It is rare, however, to find an adhesive-bound book of high quality.

Regardless of how well it is bound, a book will deteriorate rapidly if it is subjected to careless handling or improper storage.

Enemies of Books and Documents



Heat

Heat is one of the worst enemies of paper. Untold numbers of documents and books have been ruined because they were stored in a hot attic or above a radiator. An attic may easily reach 120 degrees Fahrenheit, or more, which is about 50 degrees above normal room temperature.

Heat affects paper by increasing the rate of chemical reactions. A useful approximation is that the rate *doubles* for each 18 degrees Fahrenheit rise in temperature. Paper, therefore, should be stored in a cool place but, as indicated below, not under conditions that will result in mildew.

Humidity

Humidity, alone, is not an enemy of paper; in fact, without some moisture paper loses its flexibility and becomes brittle and susceptible to damage. Very dry paper needs gentle handling. If folding or unfolding is necessary, the paper should first be exposed to a humid atmosphere.

High relative humidity and heat promote mold growth. A relative humidity above about 70 percent should be avoided. Books should not be stored in a basement unless the area is properly insulated and has adequate vapor barriers (foam glass, asphalt, plastic film, aluminum foil) built into the structure.

Wide variations in humidity can also be damaging. When the moisture content of paper changes, the individual fibers expand or contract. Paper so stressed deteriorates faster than paper that is maintained at a uniform moisture content. Therefore, cycling of relative humidity and temperature should be avoided as much as possible. Thus, an attic is a particularly hostile storage area for paper, and a damp basement is little better.

Light

Radiant energy, particularly in the blue and ultraviolet ranges of the spectrum, can be highly damaging to paper. Direct exposure to bright skylight and sunlight especially should be avoided, as both are relatively rich in ultraviolet. Even fluorescent lights can be destructive if exposure continues over a long period of time. Many museums provide protection from radiation damage by covering their displays with black cloth between viewings, or by building ultraviolet filters into the display-cases.

Sulfur Dioxide and Other Air Pollutants

Sulfur dioxide is a product of the oxidation of sulfur compounds that exist as impurities in many fossil fuels such as coal, oil, and natural gas. Sulfur dioxide is converted into sulfurous acid, which is oxidized to sulfuric acid in the paper. Much harm was done to books in the era when open coal fires were used for heat and natural gas was used for illumination. This is especially noticeable in many old books where the outside edges of the leaves are weak and discolored. Oxides of nitrogen have also been known to cause discoloration of some varieties of coated sheets.

The fresh-air supply to the air-conditioning systems of large buildings can be washed to remove pollutants, but this solution is too expensive for most people.

Books should be protected from dust and should be cleaned by vacuuming. Dust that becomes imbedded in paper can be quite abrasive, especially when combined with large changes in relative humidity.

Insects

Depending on the climate and the geographical area, books and papers are subject to attack by many household pests including silverfish, bookworms, termites, moths, and many others. The most effective solution of this problem is to use the services of a professional exterminator. Many insects can be controlled by spraying baseboards and bookshelves with a suitable insecticide (as described in the U.S. Department of Agriculture bulletin "Controlling Household Pests," listed in the bibliography).

Care of Books and Documents

The care and preservation of a book or document begins the moment you first take it in your hands. Some of the recommendations below may seem obvious, but they are often neglected.

Papers that are expected to endure should not be folded, since the physical act of folding breaks some fibers. Store unfolded in file folders or document containers.

New books should be opened gently. Separate the pages a few at a time, and run your finger lightly down the center line. If you open a book carelessly, or spread the pages too widely, you may break the glue line and cause permanent damage. Damage also may occur when a book is pressed too hard against a copying machine to achieve a good image.

If you want to mark your place in a book, use a book mark. Never turn down a corner of a page or lay the book open, face down, on a flat surface.

When dust accumulates on books it can best be removed by vacuum cleaning or by dusting with a soft brush.

Cloth and buckram bindings require very little attention, but leather bindings should be treated with a leather dressing compound at least every two years. A suitable dressing may be prepared as follows:

> Melt two parts of lanolin in a double boiler; add three parts of neat's-foot oil; and stir the mixture until the consistency is uniform. A small quantity of cedar oil may also be added. Apply a small amount, and work into the leather with a cloth. (Lanolin may be found in most drug stores, and neat's-foot oil may be found in hardware or drug stores.)

Do not pack books too tightly on a shelf. They tend to stick together, and removal may cause damage to the book spines.

Do not pack or shelve heavy books, such as dictionaries, with the long facing edge (fore edge) down. This puts a heavy strain on the binding and may cause a separation at the glue line.

Special boxes are available for the storage of documents. For information about construction and quality, consult the Federal Specification PPP-B-665B, Boxes, Paperboard, Metal Stayed, May 20, 1969. Copies can be purchased at 10 cents per copy from General Services Administration, Special Activities, Washington Program Division, Bldg. 197, Washington Navy Yard Annex, Washington, D.C. 20407.

Documents may be damaged by storing them in unbleached envelopes or in contact with newsprint or very acidic paper. Impurities can migrate from one sheet of paper to another.

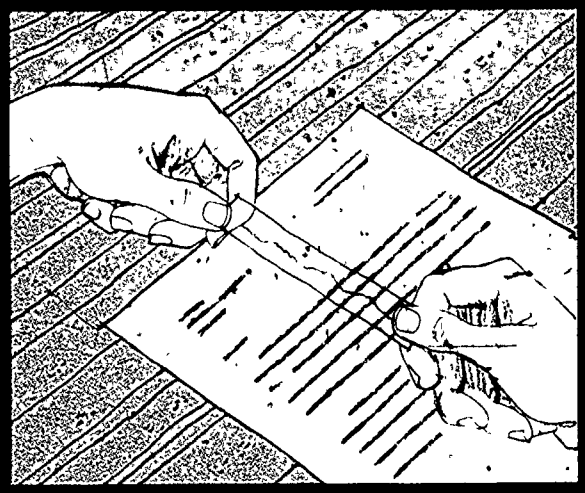
If insects are a problem, call in an exterminator.

A publication fastened with staples should not be stored next to bound books, as imperfectly stapled publications can easily be torn, and can also damage adjacent books.
Avoid as much as possible:

1. Sunlight, strong indirect natural light, and strong artificial light.
2. High temperature.
3. High humidity at a temperature high enough to encourage the growth of mold.
4. Frequent cycling of temperature and humidity.
5. Dust.
6. Chemical vapors.
7. Wood-, coal-, or gas-burning space heaters.
8. Attics, because of their extremes of temperature and their generally dusty atmosphere.
9. Basements, because of their high humidity, unless the building is properly insulated and the floor and walls equipped with vapor barriers.

Air conditioning in homes and apartments is very helpful in maintaining temperature and humidity at reasonable levels.

Minor Repairs on Books and Paper



Tissue Reinforcement

First aid for paper demands a knowledge of what *not* to do as well as what *to* do. Many documents have been damaged beyond repair by the application of mending tape, or by lamination with a plastic that was less stable than the document under repair.

Except for the repair of torn pages with tissue and paste, repair of a valuable book or document should not be attempted by anyone except an expert. If you do not wish to invest in a repair job at present, handle the item as little as possible until you are able to have the job done properly.

Most adhesives should be avoided for repair of valuable papers. A simple adhesive may be prepared from 10 grams (⅓ oz.) of corn starch and 200 cm^3 (7 fl. oz.) of water. One gram (about one level teaspoonful) of precipitated chalk (calcium carbonate) is added as a buffer against acid. Make a paste of the starch and precipitated chalk and allow to stand at least 15 minutes, with frequent stirring, to allow the starch to swell. Pour the mixture, slowly and with continuous stirring, into 170 cm^3 (6 fl. oz.) of *vigorously* boiling water. The starch should be thoroughly wetted, and the water should be kept at a vigorous boil to ensure success. Heat in a double boiler with continuous stirring for about one hour, cool, and add a few drops of formalin as a preservative. Add more or less water as necessary, as considerable variation may exist among starches from various sources. Alum should never be used as a constituent of starch paste.

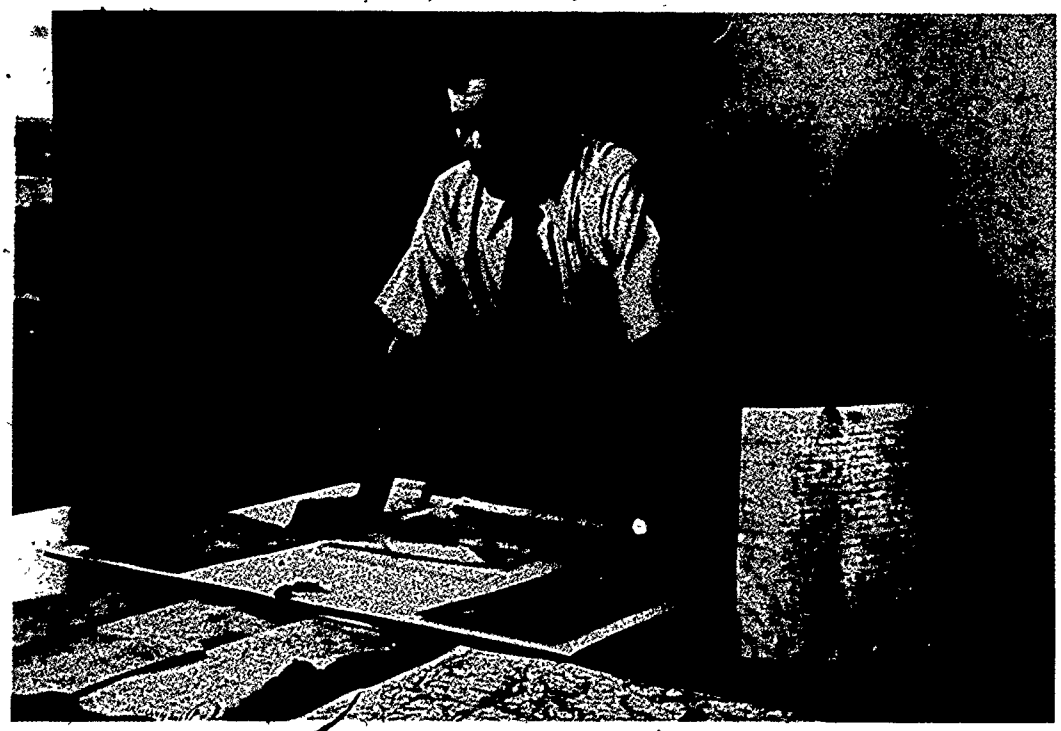
A strong tissue, such as Japanese tissue or lens tissue, may be used for repair or reinforcement. If the area to be repaired is about 1 inch square, or smaller, or a strip not wider than about ¾ inch, it may be sufficient to repair only one side. Tissue should be applied to both sides of larger areas, or the paper will tend to curl. A neater finish, with no hard edges, is obtained by tearing, rather than cutting, the tissue. For large areas, on weak paper, the tissue is best cut with pinking shears.

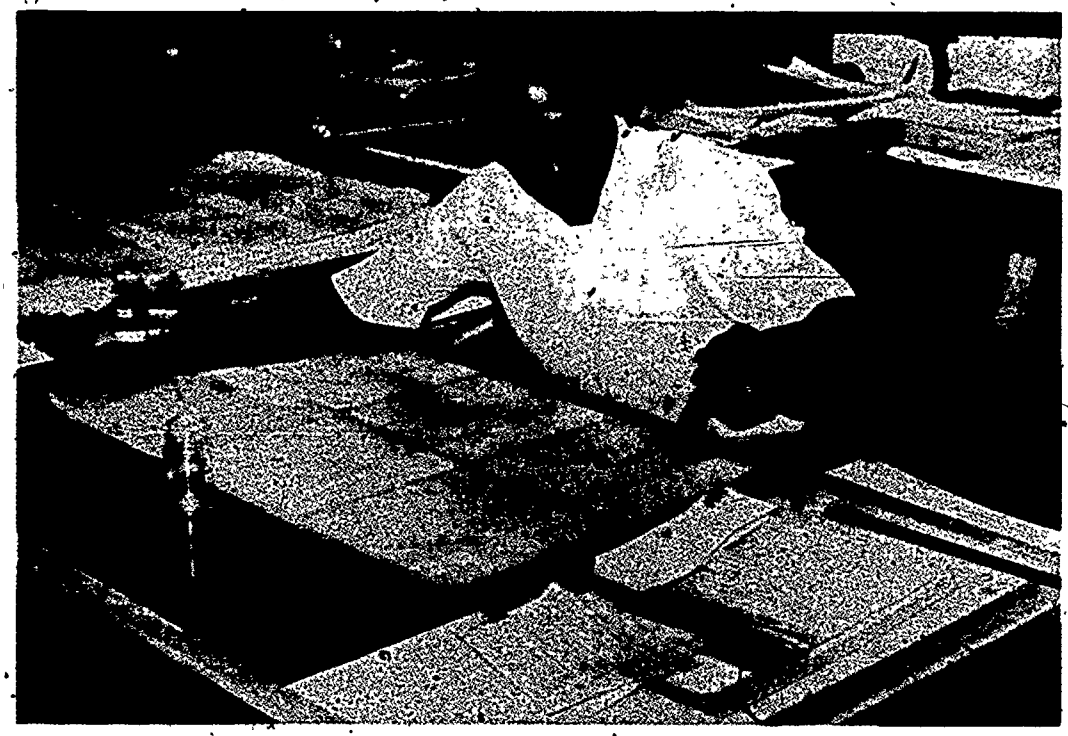
First apply the starch adhesive sparingly to the area of the document under repair. Do not apply adhesive to the tissue. Place the tissue on the area covered with adhesive, smooth it with the fingers or with a roller, cover each side with a sheet of waxed paper, and allow to dry under sufficient pressure to keep the paper flat. You should experiment with the consistency of the paste and the application technique before attempting to use this procedure on a valuable document.

Mending Tape

Pressure sensitive plastic tapes are satisfactory for repair of documents of short-term value (perhaps five years), but there is no type of pressure sensitive mending tape that is known to be satisfactory for repairing valuable records. Some adhesives tend to discolor with time and become insoluble; and on some tapes the adhesive is initially insoluble in nearly all solvents. Removal and repair thus becomes a difficult problem even for an expert.

Cloth tape may also be used, but only for the repair of documents of short term value, or for temporary repair to prevent loss of a part of a document.



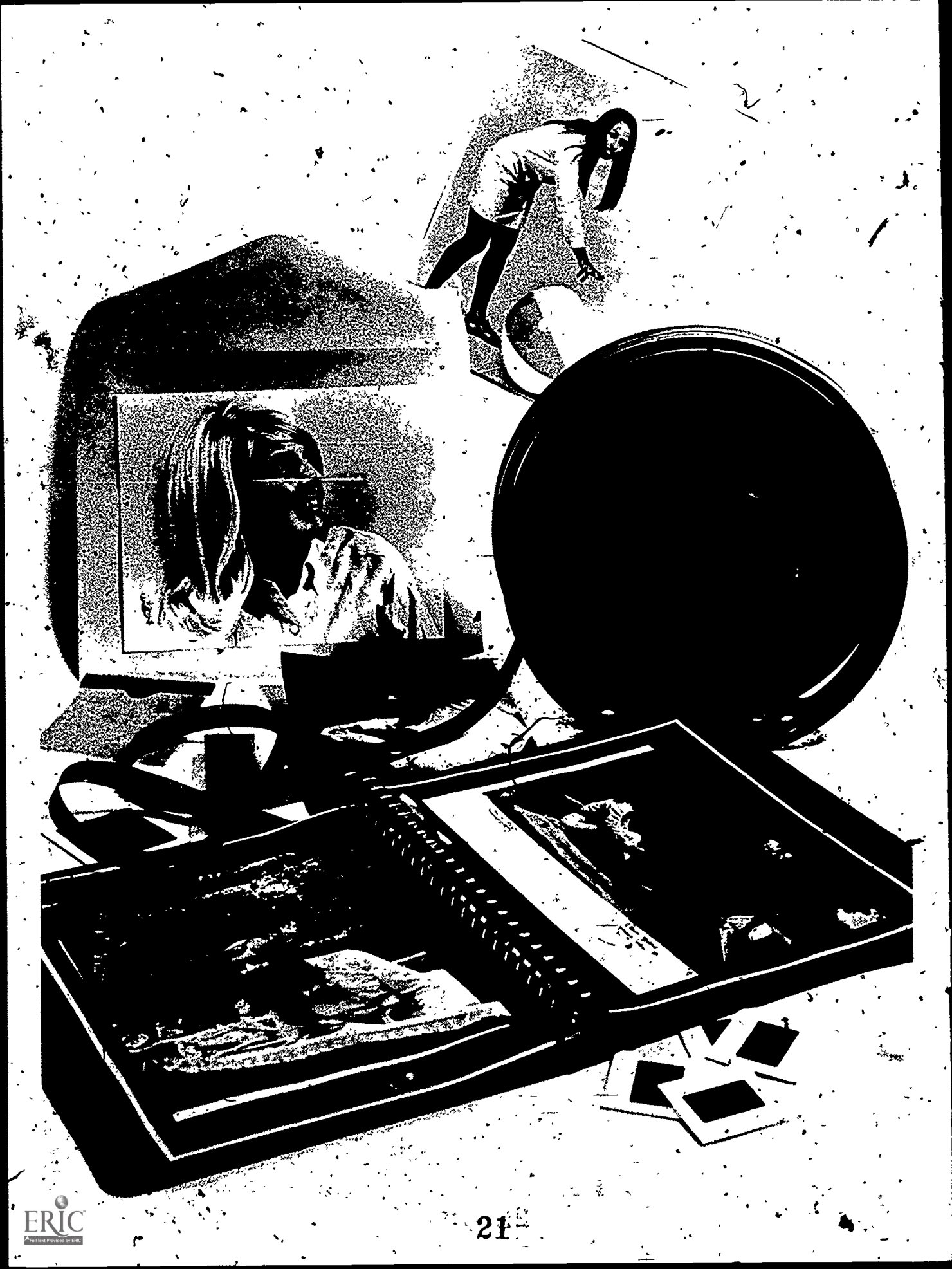


Professional Repair and Restoration

Lamination is the principal repair process used by experts in the United States. A specially formulated cellulose acetate film and a thin reinforcing tissue paper are bonded to each side of the paper by means of heat and pressure. Only cellulose acetate films that possess suitable stability should be used. Unfortunately, this is a technique which can be used safely only by an expert, usually with the aid of expensive equipment.

The document restorer usually deacidifies the paper before it is laminated. "Deacidification" consists of neutralizing the acid in paper by using a solution of calcium or magnesium bicarbonate. This also deposits a small amount of calcium or magnesium carbonate in the paper.

A professional document restorer should be consulted concerning damage by mildew and faded writing. Further information on the storage and repair of records, containers for storage, exhibition of documents, mending tissue, laminating film, and a list of competent document restorers may be obtained from the Preservation Officer, National Archives and Records Service, Washington, D.C. 20408.



Care of Photographic Films, Negatives, and Prints

Negatives

If most photographic materials are properly processed, handled, and stored, they should last for a very long time. Negatives should never be picked up between the thumb and forefinger. This leaves fingerprints on the film which often cannot be removed from the emulsion. There are also chemicals which exude from the body through the skin and adhere to the emulsion, causing chemical deterioration. Frequently the fingerprint cannot be removed and will show on the finished print. Handle negatives with clean white cotton or plastic gloves, or hold the film lightly with the outer edges between the thumb and forefinger.

When negatives are received from the processor, they should be placed in separate envelopes; or, if several are stored in one envelope, they should be separated by sheets of thin paper. This will help to prevent scratches.

Envelopes for negatives should be of good quality paper. Copies of Federal Specification G-E-550b, Envelope, Photograph, Negative, Paper, may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402 (5 cents), and copies of ANSI Standard PH4.20-1958, Photographic Filing Enclosures for Storing Processed Photographic Films, Plates, and Papers may be obtained from the American National Standards Institute, 1430 Broadway, New York, New York 10017 ($1.50).

Insert the negative in the envelope so that the emulsion side (dull finish) is away from the glued seam, because adhesives can stain and damage the emulsion. The glued seam should preferably be at one side of the envelope. Since many adhesives are hygroscopic (moisture-absorbent), they may create an area of dampness in the region of the seam, which will eventually cause a stain on the negative. Glassine and brown paper envelopes should be avoided.

Negatives should be kept free from dust. Even if they are carefully stored in envelopes, dust can filter in unless the storage area is kept clean and dust-free.

Processed films should never be stored in hot attics or damp basements. High relative humidity is more dangerous than elevated temperatures, because high humidity, especially when fingerprints are present, promotes fungus growth. The ideal conditions for storage of negatives include a dark room, a temperature of 70 degrees Fahrenheit, and a relative humidity of not less than 25 percent or more than 40 percent.

Color negatives are especially fragile. Ideally, these should be stored at a temperature of about 40 degrees Fahrenheit and at a relative humidity of 30 to 40 percent.

Prints

In looking at old photographs you will frequently find some that have yellowed or become stained and discolored. The cause can be chemical contamination, unsuitable storage conditions, or poor choice of mounting materials.

Chemical contamination is more likely to be present with photographs than with negatives. The fibers of photographic paper tend to retain processing chemicals. If you do your own developing and printing, follow the manufacturer's instructions, and wash prints with extreme care. Inadequate fixing and washing are major causes of deterioration.

Prints are often stained and discolored by the material used in mounting. Many glues and adhesives yellow or turn brown with age. Rubber cement also discolors and leaves stains which cannot be removed. If possible, use photographic drymount tissue or photographic mounting corners made of paper.

Photographs should be stored in a dry, cool place, and the emulsion side of one photograph should never be placed against the emulsion side of another. A slight excess of moisture may soften the gelatin, causing the negatives or prints to stick together.

Slides

Slides require the same care in handling and storage as negatives and prints; in addition, you have to be careful about projection time. The life of color slides depends largely upon the amount of exposure to the intense heat and light of the projector. Prolonged projection with high wattage lamps should be avoided. If possible, projection time should be limited to no more than one minute for any one viewing. The heat absorbing glass should never be removed from the projector during projection, and the air intake for cooling the projector should not be obstructed.

Motion Picture Film

Motion picture films require the same care given to other films and to slides but, in addition, they can be seriously damaged by improper threading of the projector, dirt on the rollers or on the face plate of the film gate, or by bending or creasing through careless handling. The projector should not be stopped for more than a few seconds to view a particular scene as a build-up of heat may cause warping, buckling, or burn-through of the film.

If you purchase film but do not or cannot use it for some time, store it in a refrigerator. This will help keep the film fresh. Before it is used, however, it should be allowed to stand for at least two or three hours, or until it reaches room temperature. Most films can be safely stored this way without harm because they are usually sealed in aluminum foil. Storage in a refrigerator should be avoided after the package has been opened.

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AE-7, **Storage and Care of Kodak Black and White Film in Rolls**

AE-22, **Prevention and Removal of Fungus on Processed Films**

AE-91, **Care of Your Color Prints**

C-24, **Notes on Tropical Photography**

D-23, **Handling, Repair, and Storage of Kodak 16-mm Motion Picture Films**

E-30, **Storage and Care of Kodak Color Films**

J-19, **B/W Processing for Permanence**

P-12, **Filing Negatives and Transparencies**

P-108, **Storage and Preservation of Microfilm**