

Storage Room

Classification of Films for Storage

You must consider many factors when deciding on film storage, such as the various combinations among medium and extended life expectancy storage periods. You need to think about your personal needs; for example, how long will the film mean anything to those who may see it? If it fails as a current document, what about its historical value? A film on how to start a Model T Ford by cranking doesn't have much relevance as current instruction, but it's a powerful reminder of the route we have come in this century.

When you consider the need for film storage of any kind, you must classify the film for its potential future use by its value as a record and by the length of time that it should be stored. Then find the best answer within your own resources.

For most of you, longer-range storage and preservation will probably not be an issue. You will probably use today's films today, and keep yesterday's films around only between frequent or fairly frequent screenings. You will have to make decisions.

Here is a checklist you can use as a guide:

The storage need is

- medium term to 10 years extended life expectancy
- Extended life expectancy 100 years or more
- combination of these

The films to be stored are

- **acetate or ESTAR Base**
- black-and-white (silver)
- color (dye)
- **nitrate**
- black-and-white (silver)
- color (dye)

The film is

- camera original
- release print
- intermediate form

Actually, only safety film (triacetate or polyester base), which carries silver images, can be used for extended life expectancy records-500 years for polyester base and 100 years for acetate. In some cases, there may be a combination of nitrate and acetate base films, with either silver or dye images, that have great historical value. You may need to preserve these different films even though you can't afford the expense to go through the separation method. The first thing that must be done is to

segregate acetate and nitrate films for storage, because the two film bases do not mix, and nitrate is not suitable for any permanent storage record. Acetate base films can be chemically attacked by the gases given off by the decomposing, unstable nitrate-base films. There is no need to segregate black and-white and color films that have the same type of base.

We've discussed some of the hazards and problems of maintaining these products over short- and long-term periods under various conditions. Film is very much a match for paper, probably the oldest vehicle used for records and expressive arts. Modern safety film is more resistant to fire than paper. Let's now explore storage factors other than just temperature and relative humidity.

Commercial Storage of Acetate Film Preparation for Storage

Before you store any films, be sure to repair and clean them. Mount negatives on suitable waterproof cores and prints on cores or reels. Put the rolls inside clean cans, preferably one roll to a can. (With black-and-white separation films, it is advantageous to store all three separations in the same can so they have identical storage histories.) Do not tape (seal) the cans.

Note: Films destined for projection should be wound emulsion-in, as specified in SMPTE Recommended Practice RP-39.

Educational-film users (very often do-it-yourselfers) need to carefully consider special situations. Generally, most of us are concerned with only short-term storage of films that travel a lot and often through somewhat leicithin-careful hands. Many films are destroyed because they're improperly handled. Your films can lose their educational value before being faced with the question of how to keep them around longer. Nevertheless, it's important to keep them clean and in good condition.

Storage facilities can be fairly simple rooms or closets maintained at about 24°C (75°F) or lower. If the room temperature is regularly at about 75°F, you will need air-conditioning to cool the room and a humidifier or dehumidifier to control the relative humidity at a range of 20 to 60 percent. It's best to have the RH between 20 and 30 percent so you can humidify or dehumidify accordingly. Lower temperatures are always preferable, so be sure to allow enough warm-up time when moving unprotected film to a warmer environment. Keep films out of direct sunlight, even if they are in cans. Sun-struck cans can get very hot inside, even when the room temperature is normal. Vertical storage of film cans (for short-term storage of films that are shipped a lot) allows more air circulation and easy access. For longer storage periods, you should utilize horizontal storage to reduce potential film-distortion problems.

Safe film storage is no better than the reels and containers that are used. Containers must be clean inside and out, and the reels must be in good condition. Bent, chipped, nicked, scratched, or broken reels almost always damage film. To avoid confusion

and prevent unnecessary handling, clearly and prominently label the films. Ship films in adequate containers. The purpose of any container is to protect the goods inside, so take extra care to package film for shipping and storing.

Below is a partial list of providers of adequate film containers, or you can contact one of the Kodak offices listed on page 80 for names of other suppliers. These companies are mentioned for the convenience of our customers. This does not constitute a recommendation or endorsement by Eastman Kodak Company.

Motion Picture Enterprises Inc.
P.O. Box 276
Tarrytown, NY 10591
(212) 245-0969

Taylorreel Corporation
155 Murray Street
Rochester, NY 14606
(585) 328-1262

Research Technology International
4700 Chase Avenue
Lincolnwood, IL 60646
(708)677-3000

Motion picture film on safety base can be stored safely in any suitable room for a reasonable period. The film, itself, doesn't constitute any more of a fire hazard than an open stack of bound books. So, sprinklers may not be necessary unless required by law.

If the acetate safety film doesn't enjoy the comforts of air conditioning, store it on one of the main floors of the building. Basements are too damp and top floors can be too hot in certain seasons. Get a room away from southern exposures. Use a room protected from accidental water damage from rain, water pipes, sewers, or floods.

Once you locate the ideal storage room, get suitable shelves or steel cabinets. Keep the lowest shelf at least six inches above the floor just in case of water, and keep the shelves and cabinets away from steam pipes, radiators, hot air ducts, and other heat producing sources. For long term storage, stack the films horizontally, rather than on edge, to minimize physical distortion. But don't stack them more than six or eight cans high because they're heavy and the bottom ones will be difficult to remove.

For film storage, the main thing is to stay away from attics and basements, and to maintain a room that offers a clean, cool, stable environment. Ideally, storage should be separated from work and traffic areas, especially if the collection has a large number (5,000 or more) of prints.

Minimal equipment includes a thermometer and humidity meter. Bare floors are best, no carpets. If possible, install tile floors because tile is easy to clean, and using it lessens the chance of static generation and its attraction of dust to the film. Concrete, if not treated, will create harmful dust. There should never be food, drink, or smoking in the storage area.

Storage Relative Humidity

Processed film is sort of average when it comes to relative humidity. It functions best at moderate temperature and humidity. If there's a significant amount of high relative humidity, monitor the storage room carefully and chart the readings. Prolonged exposure to relative humidity in excess of 60 percent can lead to fungal growth on gelatin emulsions irrespective of the type of film base. Check with the weather bureau to see how long the relative humidity may remain over 60 percent. A dehumidifier may be needed. See the section on "Storage in the Tropics" for the precautions necessary in tropical climates.

Those in arid climates need to be sure that their storage areas are not consistently under 15 percent relative humidity or else film will become brittle. A humidifying unit may be needed. Suitable units are available from manufacturers around the world. Be sure that the controlling humidistat is set no higher than about 50 percent to prevent overhumidification.

Camera originals or intermediates in short term that may be used for printing should be stored at the RH of the printing rooms. This room to room equilibrium prevents film size change, which helps to keep the registration accurate while printing.

High relative humidity and temperature, over an extended period, can destroy a film. Low temperatures and humidities can help to preserve films, unless the relative humidity has been below 15 percent for an extended period.

Storage Temperature

Films on safety base are sensitive only at temperatures that run significantly above 21°C (70°F). At about 27°C (80°F) for prolonged periods, distortion is likely. However, even 2 or 3 weeks at 32° to 48°C (90° to 100°F) is not a serious problem, unless the humidity also rises above the recommended levels. Low storage temperatures are best, so long as the RH doesn't get above 60 percent, which can lead to fungus. To prevent moisture condensation, let the films warm to room ambient temperature before opening the cans. These conditions should be suitable for storage times up to 10 years. Color films will keep better at lower temperatures and relative humidities.

Recommended Medium Term* Storage Condition for Processed Motion Picture Film

Film Type	Temperature	Relative Humidity ** (%)
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B&W on cellulose ester base	25 degree C + maximum (77 degree F)	20 - 50
B&W on polyester base	25 degree C + maximum (77 degree F)	20 50
Color on cellulose ester base	10 degree C ++ (50 degree F)	20 30
Color on polyester base	10 degree C ++ (50 degree F)	20 30

* A minimum of 10 years; as defined in ISO 2803 or ANSI PH1 43-1985, Practice for storage of processed safety photographic film. + Storage at less than 20°C (68°F) is preferable. ++For normal short term commercial storage, 21°C (70°F) at 40 to 50 percent RH is adequate. ** RH of 60 percent should not be exceeded for a medium term environment.

Storage in the Tropics

If 32°C (90°F) at 90 percent RH is typical for many weeks a year, there is little chance of preserving films without rather special or even heroic efforts. Under these conditions, you must protect films from humidity if you plan to use them later.

The following useful methods of preserving acetate safety film are arranged in order of decreasing cost and convenience; the "top of the line," comes first.

Automatic Air Conditioner

Automatic air conditioning can control both temperature and relative humidity. If the building is also needed for some other purpose, such as a printing laboratory, an economical combination can frequently be worked out. This is not a do it yourself task. The services of an architect and an air conditioning engineer are usually required. This is a very costly investment but well worth the expense preserving unreplaceable films.

Dehumidifier

The next best method to dehumidify a small room while keeping the temperature below 24°C (75°F). The room must be kept reasonably airtight to reduce the chance of moist air. To do this, vapor seal the walls by coating them with halit paint, aluminum paint or, better yet, paper laminated aluminum. Weatherstrip the doors and windows. Only then should you install electric dehumidifying unit. To monitor its performance, install a controlling humidistat that will turn off machine when the relative humidity has been reduced to about 30 percent.

Such a system will not cool the room. Remember, also, that people working in the room, who may be inspecting or repairing film, need fresh air. Don't confuse dehumidifying units with window air conditioners. The latter do take some moisture out of the air due to condensation on the cooling coils, but they don't control relative humidity. If no moisture is removed from the air, cooling results in an increase in relative humidity. (This is basements are usually damp.) If climate is humid, a

dehumidifier is necessary. A local heating and air conditioning supplier can suggest the right equipment for these needs.

Desiccation with Silica Gel

Rolls of film can be dried by means of activated silica gel. This must be done every time the films are used. Hopefully, there will be few places in the world with a need to use this type of procedure. Also, remember that the edges of a roll of film dry first, possibly causing some buckle in 35 mm film, a condition that can cause focus problems. Filmhandlers who live in the tropics will need to pay the price of greater care in all film operations. Fungus is a constant threat, especially if the RH is above 60 percent for long periods of time. Refer to KODAK Publication AE-22, Prevention and Removal of Fungus on Films and Prints. Frequent inspecting and cleaning are more important for tropical filmhandlers than for handlers that live in temperate climates.

Chemical Contamination

Many chemicals surround us, whatever the climate or setting, and constitute a serious threat to safe film storage. Chemical fumes, such as hydrogen sulfide, hydrogen peroxide, and sulfur dioxide (often present in coal burning regions), may cause slow deterioration of film base and gelatin and gradual fading of color photographic images. If these or similar fumes are known to be present in your locality, you need to construct a storage facility to guard against them.

One of the reasons why we emphasize the sorting of film types and segregating nitrate base films from any safety films, is that decomposing nitrate films give off nitrogen dioxide fumes which damage all three components of acetate and polyester base films the developed image, the gelatin, and the base.

Water Damage

Another hazard for film that can significantly shorten its life is water from floods, fire fighting, burst pipes, leaky roofs, or other such sources. (And yet, if it wasn't for water, the film could not have been processed.) You can keep water damage to a minimum through quick salvage actions. Since very few motion picture laboratories offer film cleaning services for water (and mud) damaged film, a salvage job is usually a do it yourself project as mentioned in the following steps and requires manual skill, patience, and a lot of improvising.

1. Keep the roll of film wet. If the film dries, the convolutions may be stuck together, ruining the film. For holding wet or muddy films prior to the cleaning operation, immerse the roll completely in containers of cold water, below 18°C (65°F). The cold water will help prevent both swelling and softening of the emulsion, which are the major causes of damage.
2. With the roll completely submerged underwater, gently rub the edges of the film to remove most of the mud and silt. Make frequent water changes.

3. Unwind the wet film carefully and slowly. Pass the strand of film under running water to remove any remaining mud or silt. In extreme cases, a gentle scrubbing action with a cotton swab may be needed to remove stubborn particles. Be careful in swabbing the film because the wet emulsion is very susceptible to physical damage. From the running water, pass the film through a tank containing water and a laundry or dishwasher type of water softening solution to minimize spotting. Avoid any sudden temperature changes in the wash waters.

4. Drape the film carefully on a wash line to air dry. Try to keep the drying area dust free and avoid any surface contact to the wet emulsion side of the film. When the film is dry, clean and lubricate it by hand with a suitable film cleaner, as you wind it onto a reel. The ideal way to recondition water damaged film would be to have it go through a normal motion picture processing machine while using the proper solutions for the particular damaged films. One of the companies that restores or rejuvenates films may be able to help you.

Note: The chemicals in this solution may be restricted and in some areas considered toxic.

Inspection

Nothing in the nature of human society stands still. You can't either when it comes to keeping an eye on films in storage, because they are always and inevitably in the process of changing, but sometimes not too obviously or rapidly. You can be sure of their condition only if the films are kept under surveillance. A regular program of inspection is a must!

Remove each roll of safety film from its container and examine it carefully on the outside and at the film end. Please remember to note if there is a vinegar like (acetic acid) odor. If there is anything to suspect at all, you should rewind the film and thoroughly examine it. Early detection can save greater effort later and, perhaps, save the existence of a film. Frequency of inspection depends on the quality of the storage and the value of the films.

Where you stay within the safe limits of temperature and relative humidity, an inspection about every 2 years is probably sufficient. But when the climate goes beyond specified limits, increase the inspection program.

If it is truly impossible to maintain this kind of frequent and thorough inspection, you should at least sample the stored films to detect early problems that may be affecting other films. Do not fall into the comforting habit of looking only at the same films or inspecting within the same areas of the storage room. And please, if there is any sign of fungus or vinegar like odor, or other film damage, widen the search immediately, so that corrective action can be taken. Often the first indication of deterioration of acetate films is the very distinctive previously noted vinegar like (acidic acid) odor when the film container is first opened. If the situation is bad, you may need help. Be sure only those people who are familiar with good film handling techniques are

involved with inspection and segregation.

Extended Storage of Processed Acetate Film

No existing film archive has yet been put to the test of preserving vital film documents for centuries, as libraries have with their paper documents. The best information from which we can project that kind of success is gathered from accelerated testing procedures. It attempts to predict the fate of photographic materials up to a century or more. It does so by using our knowledge that heat seems to speed up history, so to speak, by accelerating the natural chemical processes that affect film.

The film archivist is responsible for materials that have great historical or aesthetic value. Since film is barely a century old and has gone through continuous research and development, you are not dealing with a set of settled questions and answers. What holds for one film may be less true, or not true, for another. You must know what kinds of films you have and what characteristics of their long range life are known. Actually, you can use only black and white (silver) images on safety or polyester base for strictly extended life expectancy purposes.

One of the best ways of providing maximum protection for the longest keeping times for film, or any other medium, is to store one or more copies in different locations. No matter what precautions you take, there is always the chance of an accident. With motion picture films, storing the original, separations, master positive, duplicate negative, internegative, or print in different locations makes a great deal of sense. Storing them at different locations doesn't mean within the same building but many miles apart to protect them against fires or major natural disasters. Let's look at ways of providing the best possible protection before discussing reasonable compromises.

Specifications for Extended Storage

Follow these procedures for extended film storage:

1. Use safety film stock that meets the requirements of ANSI IT9. 11, Imaging Media Processed Safely Photographic Film Storage. The scope of IT9. 11 is detailed earlier in this chapter. Polyester base is preferred.
2. Store the film on a moisture proof core in a suitable corrosion resistant can stacked horizontally on a shelf. Do not seal the can.
3. Locate and construct the storage space as a 6 hour fire resistive vault according to state and local building codes; the Fire Underwriters' regulations (U.S.A) permit an approved air conditioning installation (more on this later).
4. Protect the film from water damage of any type.
5. Provide sufficient insulation with a suitable vapor seal to permit satisfactory temperature control during all seasons of the year and to prevent moisture condensation on, or within, the walls

6. Condition and control the air automatically at 20 to 30 percent RH and not over 21°C (70°F). Take necessary precautions to prevent moisture condensation on film after removing it from the vault. For color films, colder storage temperatures are strongly recommended and additional recommendations may be available from the film manufacturer or from ANSI.

Preparation for Storage

If there is any doubt that the fixing and washing of the film were adequate to meet ISO or ANSI Standards, analyze it for residual hypo. If there more hypo than the standard calls for, have the film properly rewashed but only after it's confirmed that the gelatin in the emulsion hasn't already been damaged by fungus or moisture and become water soluble. If this has happened, clean the film and duplicate the film on fresh stock.

Do not expend energy on valuable film that is not clean and repaired. When you're ready to store the film, wind it on a suitable rustproof core and place it in the best metal can available, replacing the old can with a new one as needed. Be sure that the lid is loose fitting to let in conditioned air while keeping out dust. If you must use film in an area where the relative humidity is below 15 percent or above 60 percent, allow it to be reconditioned to the storage area's relative humidity before resuming it to the can.

Storage Vault

The archival storage vault for acetate or polyester film doesn't need to be as impressive as King Tut's tomb. However, it must be protected from outside fire, even though the safety film itself (nitrate is not a safety film) isn't a fire hazard. Fireproof buildings sometimes make us complacent, so we forget that furnishings, wiring, and other contents may be hazards. If your vault is constructed to withstand 6 hours of severe fire exposure, it is probably safe enough. Shorter duration protection will be less expensive; you have to decide what you can afford. Also get help from an architect or engineering firm for the requirements necessary for constructing valuable record vaults, ea., location, building materials, wall thickness, type of door, etc. Such information is published by the National Fire Protection Association, One Batterymarch Park, Box 9101, Quincy, MA 02269. Telephone (617) 770-3000.

The vault should be located on either the ground floor or upper floors in a fireproof building, provided that the supporting and overhead floors are of sufficient strength. A basement is often damp and sometimes can become flooded.

The National Fire Protection Association advises against air conditioning in valuable (paper) record rooms because of possible fire hazard from the outside coming through the duct work. If the climate is a problem, there probably is no choice. Proper air conditioning is almost always essential for long term preservation of extended life expectancy storage of films. The fire hazard introduced by the openings in the room for air conditioning ducts may be overcome by the use of Underwriters' approved automatic fire control dampers in ducts, installed in accordance with

recommendations of the National Fire Protection Association.

An automatic sprinkler system inside a fire resistive vault containing only safety films is not necessary. Its elimination decreases the danger of accidental water damage to the films. If a sprinkler system is not installed, keep out all combustible furnishings and materials other than the safety films and the metal containers. In this connection, consult local building codes plus the Fire Underwriters' and National Fire Protection Association's regulations concerning valuable record rooms. If you use automatic carbon dioxide fire extinguishing equipment in the film vault, you must have a warning device to permit anyone in the room to escape before the carbon dioxide is released.

Air Conditioning

Choose a competent air conditioning engineer; then work closely with that expert to be certain that the equipment recommended is capable of maintaining the temperature and humidity conditions needed year round. To help you deal with the air conditioning engineer, here are some important concerns. The local climate is an important factor. Sufficient fresh air is necessary to keep the room under a slight positive pressure for ventilation and to prevent the entrance of untreated air. A spray chamber type of air conditioner is probably indicated.

To avoid breakdowns and costly repairs, be sure to consider equipment constructed of corrosion resistant, high quality materials. Ideally, the conditioner should be located outside the vault for ease of maintenance and to prevent leakage of water in the vault in case of a breakdown. The conditioner housing and all duct work should be well insulated. The control of room conditions calls for appropriate instruments, such as a dry or wet bulb thermostat, hydrostat, or dew point controller.

Economizing to some extent (never recommended) may be done because of the leeway in temperature relative humidity requirements for the life expectancy of the films. It is possible to pass air through a cooling coil to freeze out excess moisture and then reheat the air instead of using a spray chamber. This technique prevents high humidity the greatest danger to film but doesn't prevent low humidity in dry seasons. Although this doesn't meet the requirements of the ANSI or ISO Standards, it allows the use of a lower capacity cooling system. You should check temperature and relative humidity daily with the proper equipment or use a continuous automatic monitoring system.

Clean the vault frequently to prevent the accumulation of lint from clothing and dirt from shoes, etc. if a spray chamber is used in the air conditioner, and the water is recirculated, clean the chamber too. This will prevent the formation of biological slime that can eventually decompose and give off hydrogen sulfide, one of film's chemical enemies. Air purification units also require occasional servicing. Take safeguards when equipment is turned off for maintenance or out of order.

Air Purification

Filter all air supplied to the room to remove dust. The removal of sulfur dioxide, hydrogen peroxide, hydrogen sulfide, and other such gases requires special consideration; they're often found in harmful concentrations in the atmosphere of urban and industrial areas. Determine how much these gases are a factor to the vaults. This question is somewhat complicated by the fact that safe standards for these gases in connection with film storage have not been determined. No actual safe limit of sulfur dioxide concentration for extended life expectancy storage of film can be suggested, but it suffices to say that even a low concentration, along with other ambient air contaminants, may be harmful to film stored over a long period of time.

If there is atmospheric contamination in your locality, consult an environmental engineer to help you select the best type of air scrubber, activated charcoal absorber, or other air purification equipment for the situation. You may benefit from an installation like that at the Harvard Rare Book Library with its Gutenberg Bible and other treasures.

Inspection

You don't need to inspect films stored under the conditions specified for extended life expectancy storage as frequently as those stored under uncontrolled or adverse conditions of commercial storage. But you should still inspect films in extended storage at least every 2 years.

Special Considerations for Color Films on Safety Base

All films require special preparation for long term storage, with added attention to color, because of the three dye layers. The dyes used in EASTMAN Color Films are as stable as is consistent with the optical and chemical restrictions placed upon them by the nature of the color processes. Nevertheless, all dyes fade somewhat in time. Many valuable color films exist and need to be preserved as long as possible.

One possibility is to make panchromatic black and white copies of valuable color films onto polyester base films for extended life preservation. This is sometimes done, but one could feel that it violates the first principles of the archivist, namely, to preserve the record in its original form, which in this case means color. Another possibility is to make three black and white separation negatives from the color print. You could use them to make a new color print through a color intermediate system at any future time. This is an expensive procedure but probably justified.

Factors that contribute to fading of color films are heat, moisture, and light. Projection of motion picture film is so rapid and the form of storage is such that light is not much of a problem. For optimum preservation of the dyes in color film, store the film in a cold, dry environment for maximum permanence. The storage temperature should be 2°C (36°F) or lower with relative humidity at about 20 to 30 percent.

Laboratory tests show that the dyes in color films keep even better if the RH is lower than 20 percent. However, the lower the moisture content of the film, the more

problems you'll encounter from brittleness, curl, spokiness, and other film distortions. From a strictly physical standpoint, a relative humidity of 20 to 30 percent is considered best. It's important to arrive at a reasonable compromise for your purposes and conditions.

Conditioning Film

Ideally, the film should be put through some sort of conditioning cabinet with air circulating at about 30 percent RH. The key word here is ideally; none of our consultants can suggest where we might acquire such a cabinet. An alternative, one that could work very well, is simply to dehumidify a small, relatively airtight room and precondition the film there. Readily available commercial dehumidifiers, such as those designed for damp basement use, should be adequate in most cases. Expose the film (single strand) to such conditioned air long enough to bring the film nine-tenths of the way to equilibrium (70 to 20 percent RH, for example). In some instances, particularly in areas of very high humidity, you may have to condition the air somewhat to maintain a 30 percent RH in the room (consult a psychometric chart).

Accurate control of the moisture content of films requires some analytical facilities and technical supervision. Never desiccate any collection of color films of appreciable size and value, to be preserved indefinitely, without such facilities.

Electronic Storage

While it's possible to transfer a film image electronically to storage mediums, such as video disks and tape for future retrieval, it's not recommended. Just as film has only about 100 years of storage history, electronic storage has much less. Another reason for non-electronic storage is equipment. Will a particular piece of equipment be available 100 years from now when the material needs to be retrieved? Will the storage system be compatible with newer state of the art storage and retrieval methods? we urge caution on the use of anything but film on polyester support for extended life expectancy of film products. Film remains about the only product that has consistency worldwide for mechanical specifications.