Storage Conditions

Storage Terms
Medium term storage conditions are suitable for the preservation of recorded information for a minimum of ten years.
Extended term storage conditions are suitable for the preservation of recorded information having permanent value.

Storage Variations
The following sections will describe storage variations that may meet your wants and needs. If in doubt, it is important that you read this chapter and strictly adhere to the ANSI/SMPTE standards for the recommended film storage "life expectancy" rating and storage specifications.

General Considerations and Comparisons
Some of the best examples of European medieval clothing were found in the permafrost of Viking communities in Greenland. Mastodon flesh has been preserved thousands of years in frozen Siberian tundra. The widely traveled exhibition of King Tutankhamen's burial treasure trove illustrates still other instances of remarkable preservation of various materials, including dyes. The climate (cold and dryness) helped.

In contrast, only some of the carved stones survived mold and erosion induced by the tropical heat and wetness of Mayan Yucatan or Angkor Wat in Cambodia. For centuries, our foods have been dried with success, stored at reduced temperatures in the dark, and more recently, quick frozen to save their flavor and color.

What do these cases have to do with the storage of film? Photographic film, like food or clothing, or ordinary paper records, must be protected against water, mold, chemical, or physical damage. It must also be protected against extremes of relative humidity and heat. The quantity of moisture held by a photographic film stock reaches an equilibrium determined by its chemical properties and by the relative humidity of the air.

Relative humidity (RH) compares the amount of water vapor in the air with the greatest possible amount that it could hold at the same temperature. If it's carrying half its capacity, its RH is 50 percent and can be measured by simple calibrated humidity indicators. Relative humidity is always a factor in film storage, but it becomes especially bothersome at high temperatures because the moisture carrying capacity of hot air is greater than that of cold air. Therefore, film is more susceptible to change from high temperatures, because it's also most susceptible to attack from moisture. All of us know this from our own experiences in combinations of hot and cold air, wet and dry air.

We all know certain reactions occur faster at higher temperatures. Time is also important with temperature and relative humidity closely interwoven.

Storage of Raw Stock
When film reaches an appropriate moisture equilibrium after manufacture, it is carefully

put into a film can and sealed with tape. The can is now usually impervious to normal levels of relative humidity, but some cans may rust. Short term storage in low or high relative humidity isn't immediately threatening so long as the packages of raw film remain sealed.

Cold temperatures are best for slowing the inevitable changes in sensitivity. If raw stock must be kept for periods of up to 3 months, temperatures of 13°C (55°F) or less are appropriate. If raw stock must be kept longer than 3 months, freezing at -18° to -23°C (0 to -10°F) is recommended. After any cold storage, be sure to allow the films to equilibrate slowly to the ambient temperature where it will be used. This is necessary to prevent moisture condensation and spotting. Conditioning time will vary with the thickness of the packages and the temperature and dew point of the outside air. A 100-foot roll of 16 mm can take as little as 1/2 hour to condition whereas a 1000-foot roll of 35 mm may take up to 3 hours. Do not open the packages if they feel colder than the ambient temperature. Always use films soon after purchasing.

Raw stock must be protected against harmful gases and radiation. Some of the harmful gases are formaldehyde, hydrogen sulfide, hydrogen peroxide, sulfur dioxide, ammonia, coal gas, and automobile engine exhaust. Also to be avoided are vapors from solvents, mothballs, cleaners, turpentine, mildew or fungus preventives, and mercury. The chemical vapors can attack the photographic emulsion. Some of the vapors may slowly penetrate the tape that seals the film can. You may be shocked at how many of these gases, vapors, and fumes are in your closets or storage rooms.

Some, such as ammonia, formaldehyde, and hydrogen sulfide (rotten eggs), are easily recognized by their sharp, pungent odors. Of these three, let's look at the one that may be the least familiar, formaldehyde. You may associate this multi use chemical only with biological specimens. Formaldehyde can be all around us in products, such as the particle board and plywood in walls, cabinets, or furniture and also in some types of insulation and many adhesives and synthetic fibers.

Raw stock must be kept away from excessive heat and water which would make it tacky. The temperature in a closed automobile in the sun can easily register over 55°C (130°F). This somewhat fragile material film is especially sensitive until it's exposed and properly processed. An area of particular concern for protecting raw stock is radiation, whether it be an obvious source or ambient. Always process film soon after being exposed to lessen the chance of contamination.

Ambient Background Radiation (Effects on Raw Stock)
Ambient gamma radiation is composed of two sources: a low energy component which arises from the decay of radionuclides and a high energy component which is the product of the interaction of cosmic rays with the earth's upper atmosphere. The radionuclides responsible for the low-energy photons exist in soil and rock and are carried into earth derived building materials such as concrete. Lead shielding or storage deep underground may be helpful, but for long-term raw stock storage, radiation will still be a factor. Upon exposure to ambient-background radiation, photographic materials can exhibit an

increase in minimum density, a loss in contrast and speed in the toe, and an increase in granularity.

The change in film performance is determined by several factors, such as the film speed and length of time exposed to the radiation before the film is processed. A film with an Exposure Index (El) of 500 can exhibit about three times the change in performance as a film with an El of 125. While this effect on a film product isn't immediate, we still suggest exposing and processing the film soon after purchase. We recommend a period of no more than six months from the time of film purchase before exposure and processing, provided it has been kept under specified conditions. Films kept for extended periods beyond six months may be affected, especially the faster films, even if they have been frozen. The only way to determine the specific effect of ambient-background radiation is to make actual tests or measurements by placing a detector in the location where the film is stored. The most obvious clue is the observance of increased granularity, especially in the light areas of the scene.

Known Possible Radiation (Airports)
For the protection of travelers, all domestic airports use electronic devices and X-ray equipment to check passengers and hand carried luggage. Film can tolerate some X-ray exposure but excessive amounts will result in objectionable fog (increase in base film density) and noticeable grain. This is particularly true for very high speed films. In the United States, passenger inspection inflicts only very low-level rates of X-rays, which should not perceptibly fog most films (inspection stations can vary in radiation intensity). The effects of X-rays are cumulative, so repeated X-ray inspections can lead to an increase of fog and grain. Caution: You can avoid this danger to unprocessed film by hand carrying it, including film in cameras, and asking the attendant to visually inspect it, thus bypassing the X-rays.

Foreign Travel
Airport security measures at international and foreign airports can pose a threat to unprocessed film. Not only is there a danger from X-rays, but security and customs agents may open containers of unprocessed Mm, ruining weeks of work.

The best protection, when traveling abroad, is to write or speak to the airport manager well in advance of your arrival and explain the relevant details of your trip. Give them your arrival time, flight number, and departure time. List the equipment and film you're bringing to your destination. Ask if there are any steps you can take to expedite matters and ensure the safety of the film. Repeat the process before leaving the foreign country.

For international travel, you may find it worthwhile to work with an export company or customs broker. These are private companies that expedite the handling of international shipments and do the paper work involved. Check "Exporters" in the yellow pages of the telephone directory.

Another way to avoid problems is to have the film processed in the country where it was exposed. Eastman Kodak Company can help you find a local laboratory

General
Throughout this discussion the conditions for motion-picture films used commercially by theater professionals will be described. Also included will be educational and business uses of motion-picture films, where facilities, expected lifetime of the film, and even the training of some of the people handling the film in these settings are quite different. Later, we will treat the problems of handling and storing nitrate-base film and the special demands of safety base very long-term storage.

One of the advantages of processed film is that it's no longer light sensitive. But, as we've pointed out earlier, it's subject to inevitable change over time. So some important decisions and preparations must precede any storage.

Decisions involve the length of storage time and the quality standard that needs to be achieved. Preparations include getting the film into the best possible physical and chemical shape and achieving temperature and relative-humidity conditions that will maintain those qualities to expectations, while preserving the film against such other dangers as floods or leaking pipes, fire or hot sun and heating pipes, earthquakes or falling ceilings or shelves.

Here are some basic questions that you must answer in establishing adequate storage conditions:

- How long do I intend to store the film?
- What kind of film is it?
- What standard of preservation am I trying for?
- Will my ordinary storage room suffice?
- If not, what special storage conditions can I afford?

Most films sit more than they run. They sit in containers and also travel great distances while being bounced, heated, and even frozen along the way. When films run, they are expected to be sharp, clean, and to meet all other demands of a first-class presentation. Therefore, storage facilities and the care with which films are handled, both in and out of storage, are crucial. Consider films as if they are live images, and treat them that way. Film is not a dead substance; it's often highly responsive and somewhat sensitive.

Protection Required
In addition to protecting film against the more obvious dangers, you must guard it against high relative humilities (RH) which accelerate the fading of color dyes, damage the gelatin, and promote the growth of mold, as well as the decomposition of safety-acetate base. High RH also speeds shrinkage, doubling the permanent shrinkage in some films when it goes from 60 to 90 percent for extended periods. High RH can also cause ferrotyping (photo), the formation of glossy marks on the emulsion, or even sticking when the film emulsion is wound in contact with the base.

Low RH results in temporary film curl and decreased flexibility. Fortunately, some low RH effects can be reversed when humidity rises. Very low RH in very long-term film

storage can cause the film to become brittle and crack or break during handling. Negatives, from which prints are to be made, stored at low RH may produce static marks on the print stock during printing.

Various film distortions can result from storing motion-picture film rolls at any relative humidity much different from the equilibrium RH (about 50 percent) of the film. Film edges are like import/export harbors for the exchange of moisture. When rolls in equilibrium, with air at 50 percent, are stored at 20-percent RH for extended periods, they may buckle because the edges lose moisture faster than the interior of the roll. On the other hand, fluted or wavy-edged film can result from storing 50-percent-equilibrium film at 80-percent RH.

Low temperatures are acceptable if the unopened film has a chance to warm sufficiently to avoid moisture condensation before being opened. High temperatures increase the fading of dye images, film shrinkage, and physical distortions. Other forms of protection for motion-picture film include several printing methods that are used in protecting motion pictures.

Printing Methods for Protection

An examination of motion-picture printing methods raises a number of questions relating to the reasons for certain steps, the choice of materials, and the preference of one method over another. Obtaining the answers requires a thorough knowledge of the films and their chemical processes as well as information about equipment availability, job specifications, and the quality of the end result with respect to the costs involved. If you make motion pictures for a living, you will need to know all of these details before beginning production (or have someone on the staff who can answer the questions). It's important to know what the choices are and why you may choose one particular method over another one.

Here are your printing method choices:

Method A: Let's begin with extended life expectancy records-those film documents that need to last for a very long time. Nothing can last forever, but hundreds of years or longer is possible. Color originals should be made on high-quality camera-color-negative film such as EASTMAN EXR Color Negative Film, having a set of properly exposed and processed black-and-white separation positives made for the red, green, and blue records onto EASTMAN Panchromatic Separation Film on ESTAR Base. Then you should store the original negative and separation positives and the master positive and duplicate negative, that were made from the original negative, at the keeping conditions specified earlier.

If later more prints are wanted, and if none of the color material is usable because of fading, shrinkage, or other reasons, the separations can be recombined onto EASTMAN EXR Color Intermediate Film, from which release prints are made.

Method B: If black and white separations cannot be made, and you want to keep the films for 10 to 30 years, store the master positive, duplicate negative, and original at

conditions specified earlier. For extra protection against shrinkage, the master positive and/or duplicate negative should be on ESTAR Base.

Method C: This method assumes that only prints were made from an original color negative, with no protection masters or duplicates, and that you want to keep the films for about 30 years. Store the negative at 2 ° C (36 ° F) with relative humidity at 20 to 30 percent. If the original a black and-white negative, the recommended storage conditions would be 25 ° C (77°F) with relative humidity at 20 to 30 percent.

Method D: These final comments discuss release prints, the commodity used for the show. The colder the storage the better for keeping all films including prints. Be aware that color prints never were intended to be kept beyond their useful theatrical life, which could be quite short because of possible physical damage to the film. At a room temperature of 24°C (75°F) or colder, with the relative humidity no higher than 60 percent, and if the print was properly processed, the dyes should remain relatively stable for about 20 years. (This dye stability estimate is based on EASTMAN Color Print Film, manufactured in 1990.)

Important: The optical negative sound track must also be stored with the same condition as the pictures. Optical negative sound tracks are always black and white silver gelatin. In all of the above methods, cold temperatures will extend the life expectancy.

What to Store if there ere Is a Choice (In Order of Preference)

1. Your first choice of storage priority should be polyester base black and-white separations made from the camera original, including proper contrast ratios. Because these are silver images, they will not fade but could shrink, depending on the storage conditions and the length of time they are stored.

2. Your next choice of storage should be the camera original, master positive, duplicate negative, or internegative. If you follow the specified storage conditions, these materials should be usable for at least 40 years. Some dyes may fade slightly.

3. Your last choice perhaps should be the color print prepared for projection. This material never was intended as a material to preserve a color image beyond its useful theatrical life, maybe that of a few years, depending on abuse. The dyes will maintain a much longer useful life, but physical artifacts, if the print is mishandled, will degrade overall quality.

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 lecithin-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

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

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

River City Data
212 N Smith Ave
St Paul, MN 55102

Phone"651-292-0929
Sales: info@rivercitydata.com
Web: www.rivercitydata.com