

FILM STORAGE AND HANDLING

Film seems to be derived from an old word for skin. Skin and film can be mistreated in similar ways:

- Skin can be scratched; so can film.
- Skin can be blistered by chemicals or heat; so can film.
- Skin can be damaged by prolonged exposure to the sun; so can film.
- Skin gets dry and brittle in low humidity and cold; so does film.
- Skin is susceptible to fungus in excessive heat and relative humidity; so is film.
- Skin can be burned; so can film.

But healthy skin and healthy film are strong, flexible and indispensable. We spend billions on skin care each year and know much about it. Why not consider film the same way?

STORAGE AND HANDLING OF RAW AND EXPOSED FILM

Keeping your raw stock and exposed film safe.

Raw Stock:

- Unprocessed film must be kept cool to preserve quality, ideally at 55°F / 13°C
- Keep film cool until just before shooting
- For storage of film for longer than 6 months, store at 0°F / -18°C
- Allow frozen film to warm up gradually before opening can, to avoid condensation
- Avoid prolonged exposure of film cans or camera magazines to sunlight
- Avoid storing film in hot vehicles

Exposed Unprocessed:

- Process film promptly after exposure
- Avoid "Latent Image Regression"
- Keep film cool after exposure
- If processing is delayed, put film in refrigerator
- Allow frozen film to warm up gradually before opening can for processing

The sensitometric characteristics of virtually all unprocessed photographic materials gradually change with time, causing loss in sensitivity, a change in contrast, a growth in fog level, a color balance shift, or possibly all of these. Improper storage will cause much larger changes in color quality and film speed than do variations in manufacturing. Scrupulous control of temperature and humidity, thorough protection from harmful radiation and gases, and careful handling are important to long, useful film life.

Exposed footage is even more vulnerable to the effects of humidity and temperature. It is recommended that it be processed promptly after exposure, to avoid changes known as “latent image regression”, which include loss of speed and contrast.

Temperature

In general, the lower the temperature at which a film is stored, the slower its rate of sensitometric change during aging will be. For periods up to three months, store motion picture raw stock at a temperature of 13°C (55°F) or lower, and a relative humidity of 60% or lower, during the entire storage period to retain optimum film properties.

Protect film in original packages or loaded in cameras, cartridges, magazines, on reels, and in carrying cases from direct sunlight. Never leave film in closed spaces that may trap heat. Temperatures in closed automobiles, parked airplanes, or the holds of ships can easily reach 60°C (140°F) or more. A few hours under these conditions, either before or after exposure, can severely affect film quality. If processing facilities are not immediately available, store exposed films at -18°C (0°F) but only for a few weeks at most.

Store raw stock at -18°C to -23°C (0 to -10°F) if you must keep it longer than three months or if you intend to use it for a critical use that requires uniform results. Sensitometric change cannot be prevented by such storage, but it will be minimized.

	Short Term (less than 6 months)		Long Term (more than 6 months)	
	Temperature	Relative Humidity	Temperature	Relative Humidity
Raw Stock (in original sealed cans)	13°C (55°F)	Below 60%*	-18 to - 23°C (0 to -10°F)	Below 50%
Exposed Unprocessed	-18 to -23°C† (0 to -10°F)‡	Below 20%	Not Recommended (see text below)	

*Keep sealed (in original cans) until temperature is above the dew point of outside air. (See table of warm-up times.)

†With possible loss of quality.

‡Process exposed film as soon as possible after exposure.

IMPORTANT: After a package of raw stock has been removed from cold storage, allow it to warm up to room temperature 21 +/- 3°C (70 +/- 5°F) before you unseal the can. This will prevent telescoping of the roll during handling because of possible cold-induced looseness between the layers; it will also prevent moisture condensation and spotting of the film.

Film Package	Typical Warm-up Time (Hours)	
	14°C (25°F) Rise	55°C (100°F) Rise
Super 8	1	1 1/2
16 mm	1	1 1/2
35 mm	3	5

Relative Humidity

Since a small amount of vapor leakage through the closure of a taped can is unavoidable, use additional water-vapor protection if you are going to keep motion picture films longer than a month in an area having high relative humidity (60 percent or higher), such as home refrigerators or damp basements. Tightly seal as many unopened rolls as possible in a second plastic container or can.

NOTE: It is the relative humidity, not the absolute humidity, that determines moisture content of film. Relative humidity is best measured with a sling psychrometer. In a small storage chamber, a humidity indicator, such as those sold for home use, is satisfactory.

When handling motion-picture film in high relative humidities, it is much easier to prevent excessive moisture take-up than it is to remove it. If there are delays of a day or more in shooting, remove the magazine containing partially used film from the camera and place it in a moisture-tight dry chamber. This prevents any absorption of moisture by the film during the holding period. Immediately after exposure, return the film to its can and retape it to prevent any increase in moisture content. Moisture leakage into a taped can is more serious when the can contains only a small quantity of film. When these circumstances exist, seal as many rolls as possible in a second moisture-resistant container.

Effects of Humidity

High humidity can promote mold growth and ferrotyping. Low humidity can create static marks when printing or cause buckling due to uneven moisture loss. Exposed film, particularly color film, deteriorates more rapidly than unexposed film. Kodak recommends exposing and processing all camera films soon after purchase and no longer than six months after purchase. Immediately after exposure, return the film to its can and retape the can to help prevent any increase in moisture content. Process the film as soon as possible after exposure.

Humidity lower than 50% usually increases static problems and dirt attraction to processed film. At very low humidity, film curl may become a problem (e.g., Newton's Rings).

Radiation

Do not store or ship unprocessed film near x-ray sources or other radioactive materials. Many scanning devices used by postal authorities and airlines will fog the film. Take special storage precautions in hospitals, industrial plants, and laboratories where radioactive materials are in use. You should also label packages of unprocessed films that must be mailed across international borders as follows: "Contents: Unprocessed photographic film. Please do not x-ray." In general the more sensitive the film stock the more susceptible it is to x-ray damage; i.e., the slower the film speed, the better. EI50 is safer than EI500.

Radiation effects are cumulative. The more x-ray exposure films receive, the greater the damage. Direct routing is preferable to indirect routing. A commercial carrier such as Federal Express or DHL will ship film without x-raying it, but they will inspect it carefully by hand.

Airport Security X-rays

Airports use x-ray equipment to scan checked and carry-on baggage. Film can tolerate some x-ray exposure but excessive amounts result in objectionable fog (an increase in base film density and a noticeable increase in grain). The faster the film, the greater the effects of the x-rays. Not only is there danger from x-rays, but security and customs agents may open containers of unprocessed film, ruining weeks of work.

You should never check your film with your luggage. X-rays used for checked baggage are more powerful than those used for carry-on inspection. With current security regulations your film will most likely be damaged if checked with luggage.

The traditional low dosage scanners which have been used at airports for many years to screen passengers' hand baggage are relatively safe for film up to a speed of EI200 for motion picture film or 400 ASA for still film. However, the effects of radiation are cumulative and film may be screened several times as the traveler passes

through various airports on a trip. Although tests have shown that 400 ASA still film was not affected by up to 7 passes through a RAPISCAN machine (one of the low dosage scanners), motion picture film may be affected to a greater degree by increases in grain and fog when the film is projected on a large screen.

For this reason, it is best to avoid all x-ray scanning of motion picture film.

Unfortunately, the volume of people passing through large airports on a daily basis renders hand-inspection all but impossible, and airport personnel are less willing to accommodate your special requests. If you plan to hand-carry unprocessed film through an international airport, contact the airport security office well in advance of your flight to make arrangements. Bring a light-tight changing bag in case it is needed. The changing bag will allow the inspectors to open the cans safely and inspect the film.

Once popular lead-lined carry bags are no longer practical—when inspectors can't see through the bags, they increase the x-ray intensity. Film, therefore, can suffer greater damage than routine inspection might have caused.

Suggestions for avoiding fogged film

X-ray equipment used to inspect carry-on baggage uses a very low level of x-radiation that will not cause noticeable damage to most films. However, baggage that is checked (loaded on the planes as cargo) often goes through equipment with higher energy x-rays. Therefore, take these precautions when traveling with unprocessed film:

- Request a hand inspection for all motion imaging origination films. Testing shows fog on motion imaging films even after a single x-ray scan. This increased fog flattens the entire toe region of the sensitometric curve, reducing shadow detail in a telecine or projected image. However, Explosive Trace Detection instruments provide no risk to motion picture films and can be used in conjunction with hand inspection to provide a non-destructive method of motion film inspection.

The Transportation Security Administration (TSA) recommendations for traveling with film may be found at www.tsa.gov.

The FAA provides air travelers in the United States the right to request a non-X-ray inspection of photosensitive products. For more information, see www.faa.gov. Remember that this only applies to air travelers in the United States.

Air Freight Services

We understand that express air package shipping services such as Airborne, DHL, FedEx, UPS, etc. that use their own aircraft, do not employ x-ray scanning of customers' packages on domestic routes. However, this should be verified when sending film. The same carriers may employ passenger airlines for international routes. Goods shipped as freight on passenger airlines are subject to high-intensity x-ray scanning. It is recommended that film shipped as unaccompanied freight is labeled "DO NOT X-RAY. IF X-RAY IS MANDATORY, DO NOT SHIP / DO NOT X-RAY / CONTACT SENDER URGENTLY: (details)".

Foreign Travel

Traveling internationally increases the amount of security measures at airports. Travelers should be wary of all scanners at foreign airports. You should allow for extra time at customs and security or call ahead to arrange an appointment for inspection.

It is best to plan ahead when shooting internationally. Have your film imported by an approved carrier. You can contact your nearest Kodak location to see about the best way to get film in the country you are shooting it.

Try to process the film in the country where you expose it. To find a local laboratory, contact the Kodak location nearest you.

Ambient Background Radiation (Effects on Raw Stock)

Ambient gamma radiation is comprised of two sources: a low energy component which arises from the radioactive decay, and a high energy component which is the product of the interaction of cosmic rays with the earth's upper atmosphere. Upon exposure to ambient background radiation, photographic materials can exhibit an increase in minimum density, a loss in contrast, and an increase in granularity. The change in film performance is determined by several factors, such as the film speed and length of time the film is exposed to the radiation before it is processed. A film with a speed of 500 can exhibit about three times the change in performance as a film with a speed of 125. While this effect on a film product is not immediate, it is one reason why we suggest exposing and processing the film as soon as possible after purchase. A period of about six months from time of purchase can be considered "normal" before exposure and processing, provided it has been kept under specified conditions. Extended periods beyond six months may especially affect fast films, as noted above, even if kept frozen. The only way to determine the specific effect of ambient background radiation is with actual testing or measurements and placing a detector in the locations where the film was stored. The most obvious clue is the observance of increased granularity, especially in the light areas of the negative.

Gases and Vapors

Gases (such as formaldehyde, hydrogen sulfide, sulfur dioxide, ammonia, coal gas, engine exhaust, hydrogen peroxide) and vapors (from solvents, mothballs, cleaners, turpentine, mildew and fungus preventives, and mercury) can change the sensitivity of photographic emulsions. The cans in which motion picture films are packaged provide protection against some gases, but others can slowly penetrate the adhesive tape seal. Keep film away from any such contamination—for example, closets or drawers that contain mothballs—otherwise, desensitization of the silver-halide grains or chemicals fogging can occur.

STORAGE AND HANDLING OF PROCESSED FILM

You can store exposed and processed camera films for a greater length of time than unprocessed exposed or unexposed film.

Processed Film Storage Conditions

	Short Term (less than 6 months)		Long Term (more than 6 months)	
	Temp	Relative Humidity	Temp	Relative Humidity
Processed B&W	21°C (70°F)	Below 60%	21°C (70°F)	20 to 30%
Processed Color	21°C (70°F)	20 to 50%	2°C (36°F)	20 to 30%

Effects of Humidity on Processed Film

Humidity lower than 50% usually increases static problems and dirt attraction to processed film. At very low humidity, film curl may become a problem (e.g., Newton's Rings—see text below).

Newton's Rings and Ferrotyping

Concentric bands of colored light sometimes seen around the areas where two transparent surfaces, such as two pieces of glass or two pieces of film (as in contact printing), are not quite in contact are called Newton's Rings. The rings are the result of interference and occur when the separation between surfaces is of the same order as the wavelength of light.

Ferrotyping describes a smooth and shiny blotch or series of blotches on the emulsion surface. It is caused by the presence of heat and/or moisture with pressure. Sources of ferrotyping can be improper drying conditions on the processing machine, the wound roll of film was wound under excess moisture (high humidity conditions), or the wound roll was subjected to high heat either before or after processing.

Effects of Contaminants

Certain gases such as formaldehyde, hydrogen sulfide, hydrogen peroxide, sulfur dioxide, ammonia, illuminating gas, motor exhaust, and vapors from solvents, mothballs, cleaners, turpentine, mildew or fungus preventatives, and mercury can damage unprocessed and processed film. Keep film away from such contaminants.

Handling

Do not store film near heating pipes or in the line of sunlight coming through a window, regardless of whether the room is cool or not.

Maintain the temperature as uniformly as possible throughout the storage room by means of adequate air circulation so that sensitometric properties remain consistent from roll to roll.

Handle film carefully by the edges to avoid localized changes in film sensitivity caused by fingerprints. Folding and crimping the film also introduces local changes in sensitivity. Keep the surfaces that the film travels over clean to prevent scratching of the film's base or emulsion.

Minimizing Damage to Film

Film equipment can damage film. Potential sources of damage in order of frequency are projectors, editing equipment, cleaning equipment, telecines, printers, and cameras.

General Precautions in Handling Film

Prevent damage to film by:

- Servicing equipment regularly.
- Cleaning all camera/projector film gates regularly.
- Cleaning and checking rollers and sprockets.
- Cleaning magazines regularly.

- Cleaning film regularly (see below).
- Edge waxing and/or lubricating film to reduce severe film wear.

Film Cleaning

It is a good idea to use particle transfer rollers (PTR) on film-handling equipment and to clean dust and particles off of processed film. It is best to use ultrasonic film cleaners, which are safer and more efficient than liquid hand cleaning or PTRs.

Hand cleaning—

- Use a soft cloth, non-abrasive material designed for the job.
- Only use an approved commercial film cleaner if “dry” cleaning does not remove the dirt.
- Never use carbon tetrachloride, methanol, or ethanol—they pose health and safety problems.

Treating Scratches

Scratches are virtually impossible to eliminate, but they can be minimized by:

- Reprinting with a liquid gate printer that hides base scratches and some light emulsion scratches.
- Re-washing the film for light emulsion scratches (Process RW-1).
- Lacquering (or “polishing”) base scratched film.

For a more detailed discussion of care and long-term storage of film, see KODAK Publication No. H-23, *The Book of Film Care*.

Extended Storage Time—10 Years or More

Color dyes are more prone to change than silver images when kept for extended periods of time. The following minimum guidelines are suggested for keeping films for 10 years or more.

Adequately wash the film to remove residual chemicals such as hypo. See ANSI PH 4.8-1985 for recommended levels and a testing method for residual hypo.

Some color films designed for processes other than ECN-2 and ECP-2E may require stabilization during processing (e.g., some reversal films using process VNF-1). Always follow recommended process specifications and formulas.

All film should be as clean as possible, and should be cleaned professionally. If you use a liquid cleaner, provide adequate ventilation. Adhere to local municipal codes in using and disposing solvents.

Keep film out of an atmosphere containing chemical fumes. See "Effects of Contaminants" above.

Do not store processed film above the recommended 21°C (70°F), 20 to 50% RH for acetate or polyester.

Wind films emulsion-in and store flat in untaped cans under the above conditions.

Additional information can be obtained from ISO 2803 or ANSI PH1 43-1985, "Practice for storage of processed safety photographic film."