

Storage and Handling of Processed Nitrate Film

Nitrate Base Film

Nitrate base, the pioneer of motion picture film bases, retired from our cameras and laboratories about 1951-52. Still, its very long shadow of distinguished commercial motion pictures and film records haunts many film vaults. Nitrate base films must be handled with informed care.

Cellulose nitrate base film is relatively unstable. If you store it in large quantities of about 5,000 feet or more and in non approved storage cabinets without proper ventilation, it becomes a fire hazard. Admittedly, it takes a bit of pushing to cause it to burst into flames spontaneously. For example, in one laboratory test, combustion occurred with a decomposing 1,000 foot roll of film only after it was kept at 41°C (106°F) for 17 days tightly encased in a can wrapped in insulation to retain the heat of decomposition. However, even a minor fire can cause major film losses. This example may not be that different from some storage lofts in the summertime that are uninsulated.

Cellulose nitrate decomposition is the villain. It shrinks, even to the point of becoming unusable. Furthermore, as the film breaks down, it gives off nitric oxide, nitrogen dioxide, and other gases that yellow the film base, yellow and soften gelatin, and oxidize the silver image. Later, the base cockles, becoming very brittle and then sticky. Finally, it disintegrates completely. This inevitable deterioration is usually gradual, but elevated temperatures and humidity speed it greatly.

While it deteriorates, nitrate base film makes a kind of pressure cooker of the film can in which it rests, especially when it's taped closed. If the gases can't escape, heat builds and spontaneous combustion may not be far behind. Therefore, nitrate film must never be closed in.

Escaping toxic gases (powerful oxidizing agents) can attack nearby acetate and polyester base films, so store nitrate films in their own special place and not in a place too heavily concentrated.

If the conditions are right, their image layers may last for decades or generations. Because of their great value, many nitrate base films have been reprinted on current longer lasting safety base. Somewhere, nitrate film is still with us, so we offer a few more comments.

Probability of Rapid Decomposition

If you store old nitrate base films, the first thing you need to check is the temperature of the storage area. High readings of the temperature and/or the relative humidity are unfavorable to nitrate and to other films. Are the by products of decomposition being discharged from the storage area? Is there too much nitrate in a confined area? The more rolls collected in one place, the greater the chance of trouble. with nitrate film, it's important to design separate and specialized storage compartments.

Inspection and Segregation of Nitrate Base Film

Identification is the key to initiating the proper handling of nitrate film. You need to properly identify the films in your vaults and storage areas. Don't assume all films to be acetate or polyester when some may be nitrate. Some rolls may be spliced mixtures of each. Kodak never produced 16 mm or narrower film on nitrate base. Some may have been slit to 16 mm from 35 mm for whatever reason. Also, Kodak never produced 70 mm or 35 mm color camera original or color print films on nitrate base, but they did produce on nitrate base a special black and white Eastman nitrate film for use in making 35 mm and 70 mm imbibition films (dyed by the Technicolor process).

It's important to know exactly what types of film are in your possession because nitrate fumes and fire are a threat. Conditions that may only marginally harm the acetate films can cause a nitrate base to become very dangerous. Unless you can detect some deterioration, you may have a hard time differentiating nitrate from acetate base films. Edge identification may establish the difference the easy way.

You can use ultraviolet lamps to identify EASTMAN Triacetate Films by the resulting fluorescence. A different identification tool is your nose. Cellulose nitrate has a characteristic acid odor, similar to that of nitric acid. This odor is unmistakable when a quantity of nitrate film has been stored, especially in a nonventilated area.

Evaluating the Extent of Deterioration

The nitrate film you have in storage may be middleaged, but if it was properly stored, it may be quite usable. However, if it was neglected, it may be showing signs of early deterioration. One way to determine the extent of deterioration is to look at the color of the base. If it's yellowish, or even amber, sulfiding has begun because of silver in the emulsion and some yellowing of the gelatin. The confirming test is to see if the film base is brittle and breaks easily on being bent in half, especially with the emulsion side out. At this stage, the gelatin is probably soft enough to dissolve readily if the film is wetted.

If these symptoms of decomposition are found, handle the film with care and keep it dry. Duplicate it soon after inspection, drying, and cleaning, because buckled film and sticky gelatin may make duplication later more difficult or perhaps impossible.

Spontaneous Combustion

Spontaneous combustion is self ignition of combustible material through chemical action (as oxidation) of its constituents. It develops from knowable conditions, such as deterioration, and with proper observation and care, you can prevent a chemical reaction. Nonpreventive measures, whether it's in hay, oily rags, or nitrate film, can result in a fire. With the information given in this section, you can prevent the threat of spontaneous combustion.

Apparently, fire isn't caused by cellulose nitrate in good condition. But in the advanced stages of decomposition, self ignition takes place at sustained temperatures

only slightly above 38°C (100°F). If undetected, heat producing deterioration and high temperatures, with consequent heat buildup, coincide. Such combustion isn't nearly so spontaneous as its name seems to imply!

Storage Vaults and Conditions

Carefully examine all the materials known to be on nitrate base. Detecting unstable nitrate film is by far the most important way to preserve this material. If decomposition isn't found quickly, complete destruction of the film record may result. Spot inspection only needs to be done once a year if you follow the recommended storage conditions, and once every 3 months if adverse conditions exist. Any nitrate film that is badly buckled or sticky is in an advanced stage of decomposition.

You may be able to duplicate some of these badly buckled or deteriorated films, or they may yield a fair quality print. Urgency is the word. If the film base is heavily stained and moisture from our breath makes the gelatin slightly sticky, the negatives or prints must be duplicated within 2 years while maintaining proper storage conditions.

Never wet a decomposing nitrate base negative; the gelatin may be readily dissolved. If you must remove surface dirt, use a quality cleaner carefully. Many old negatives have an iridescent dichroic or silver sulfide stain, usually on the surface of the gelatin. This is a further sign of old and deteriorated film.

Store these negatives only in small quantities and in different locations. The production of chemical vapors and heat from large concentrations of nitrate films demands special storage conditions with a special exhaust and ventilation system. This storage area should never be near safety films.

Never store any nitrate base materials in sealed containers or without ventilation. Such dead storage simply increases the rate of decomposition. Pack the reels loosely in ventilated metal boxes or cabinets, and store them in a room apart from all other photographic materials. Do not let the storage area temperature exceed 21°C (70°F). If you achieve a lower temperature without increasing relative humidity above 45 percent, that's even better. Relative humidity below 40 percent retards decomposition even more, but makes the film more brittle.

For longer storage, use an approved storage vault. The standards for design, construction, and use of storage cabinets and vaults for historical nitrate films are based on years of experience by the National Board of Fire Underwriters and are supported by the experience of the National Archives and the National Bureau of Standards.

The important principles supporting the Underwriters' regulations are based on

- elimination of all possible means of starting a fire

- control of, and protection against, the spread of fire
- segregation of large quantities of film into small protected units
- ample provision for safety to human life
- proper ventilation and exhaust system

These are the important reasons behind every detail of an approved building construction, self closing fire doors, exits, vents, light fixtures, electrical systems, heating equipment, and automatic sprinklers, etc.

Vaults for commercial storage are limited to 750 cubic feet with a vent area not less than 200 square inches per 1,000 pounds, or a total of 2,000 square inches for the standard size vault. A sprinkler is required for every 62.5 cubic feet of space or 12 for a 750 cubic foot vault.

Vaults for long term storage are limited to 100 cubic feet with a vent area of at least 2,670 square inches, and with no less than eight sprinklers. Both sprinklers and ventilation provide about five times the safeguards suggested for that of commercial storage.

Shelves in long term film vaults should be divided into individual compartments with not less than 3/4 inch thick non combustible insulating material. Each compartment should hold only one, or at most two, film containers.

The ceiling water sprinklers should be directed so that all shelves will be drenched in the event of fire. The individual containers will protect the film from water damage.

Air conditioning systems in film vaults should be installed according to regulations of the National Board of Fire Underwriters. Automatic fire dampers should be installed in the air ducts so that a fire in one vault will not spread to another and so that the toxic gases given off will not be distributed to other rooms, but will be vented outside. The Underwriters' regulations do not provide for control of air temperature and relative humidity in the storage of nitrate film other than that temperatures must not exceed 21°C (70°F). This is a safety precaution. Additional precautions are required from the standpoint of film preservation.

Nitrate Storage Conditions

The air conditions recommended for nitrate film storage are listed below. For temporary or medium term storage, temperatures up to 21°C (70°F) at relative humidities between 20 and 50 percent are considered satisfactory. Where this maximum temperature and humidity are exceeded and complete air conditioning is unavailable, dehumidification by machine would be of some advantage. Cooling alone, without automatic relative humidity control, is also beneficial, since a considerable amount of moisture can be condensed out of the air on cooling coils. Remember that all nitrate films are at least 40 years old. If possible,

Nitrate Film Storage

Film Type	Medium Term Storage		Long Term Storage	
	Temperature	Relative Humidity(%)	Temperature	Relative Humidity(%)
B & W	below 21 degree C (70 degree F)	20 - 50	below 10 degree C (50 degree F)	20 - 50
Color	below 21 degree C (70 degree F)	20 - 50	below 0 degree C (32 degree F)	20 - 30

you should store them as recommended for films of long term historical value, but because of their nature, they should be copied and then destroyed. Proper nitrate film storage conditions require some expense to achieve. Lower relative humidities than those recommended would retard decomposition of nitrate film and fading of color images even more, but most experts agree that the risk of brittleness with old nitrate film is too great. Remember that color and nitrate base films do not qualify for extended life expectancy in the hundreds of years. But proper storage conditions can prolong their useful life. For the American National Standards Institute (ANSI) and National Fire Protection Agency (NFPA) for nitrate storage recommendations, refer to ANSI/NFPA Standard 40 1988, Storage and Handling of Cellulose Nitrate Motion Picture Film. **Caution:** Never seal nitrate film in an airtight container at any time. The gases and heat created while in storage must be allowed to escape.

Disposal

Since films on nitrate base are relatively unstable, and certainly very flammable, "protection" copies should be made using the best available/affordable technology, for example, copies on stable ESTAR base films. However, since first-generation elements in good condition usually provide better image quality than any copy, they are worth preserving even after copies have been made. They should be destroyed only if they are in a seriously deteriorated condition that poses a serious risk to the nitrate film storage facility, or other films in storage. Properly preserved first-generation elements will provide the best available image quality for future restorations, as restoration technology continues to improve.

Never discard nitrate film into ordinary trash containers or into routine disposals. Check with the local environmental agency for safe disposal. Never mix nitrate base film with safety film that will be sent for silver recovery.

You must handle unstable or deteriorated nitrate films much like you would explosives. Keep such films underwater in an open suitable steel drum until disposal can be arranged. Regard as unstable any substantial quantity of films, whatever their apparent condition.

The safest and most environmentally sound method of disposal for nitrate films is high temperature, supervised incineration (but not in roll form, could explode)

coupled with effective air pollution control. If on site facilities are not available, a commercial, environmentally certified waste disposal firm should be utilized. Open burning of waste nitrate film is dangerous as well as regulated by local, state, and federal environmental laws. **Danger:** Nitrate film should never be burned in a heating furnace because the gases generated by the burning produce high pressure (explosive) and are highly toxic!

Help for Owners of Nitrate Base Film

Nitrate base films have been out of common use so long (since about 1951-52) that expertise in handling them is not commonly offered, but there are facilities that do offer this service. Unless you are an expert concerning the characteristics of nitrate films in various stages of decomposition, don't unroll the films. Let the experts do it. For help determining the historical (not monetary) value of any material on nitrate base, contact a local historical film association or International Film Archive, FIAF Secretariat, rue Franz Merjay 190, 1180 Brussels, Belgium. If they can't help you, they'll direct you to someone who can. If the film has value or you decide to have it duplicated, even if it isn't unique, one of the film archives can give you advice on the procedures for arranging duplication.

Note: Nitrate base films can't be mailed, so you will need to arrange some other method of conveying them.

And so we bid a fond farewell to nitrate base film a great pioneer resource, still highly valued, but always a challenge to our most careful film handling and storage techniques.