



# Environment

I N F O R M A T I O N F R O M K O D A K

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## *Safe Handling, Storage, and Destruction of Nitrate-Based Motion Picture Films*

Photographic films on cellulose nitrate base (nitrocellulose) were introduced by Eastman Kodak Company in 1889. This film base had excellent physical properties, but it suffered from poor chemical stability and high flammability. In 1948, cellulose triacetate support was introduced; it met the performance requirements of motion picture films and provided added safety. After 1951, no cellulose nitrate motion picture film was manufactured by Kodak.

Actual use of cellulose nitrate films in theaters has virtually ceased. However, large quantities of cellulose nitrate film for archival or other purposes still exist in storage. These films are typically kept in vaults and removed for limited projection, reprinting and restoration on safety films, or destruction.

This publication will help you recognize and avoid the hazards associated with cellulose nitrate motion picture films. To safely handle, store, transport, and destroy these films, you must understand these hazards. The information in this publication is based on requirements in the United States; requirements may differ in other countries.

The storage and handling requirements presented are primarily from the National Fire Protection

Association (NFPA), *Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film*, 1994 Edition (NFPA 40). The NFPA standards are not laws; however, states or local authorities, such as a government agency, local fire department, or a building/ electrical inspector may require compliance with the NFPA standard.

### IDENTIFICATION

Depending on the age of cellulose nitrate films, the edge of the film may be marked as nitrate film ("NITRATE FILM" or "N").

The words "SAFETY FILM" may appear in the non-image area of a motion picture film. This usually indicates that the base is made of a material, such as cellulose triacetate, that passes the ISO 435 test for burning and ignition. However, early motion picture films marked "SAFETY FILM" may have been *printed* on cellulose nitrate film, which would also carry the "SAFETY FILM" markings from print through. If a film cannot be clearly identified by markings, testing may be required to determine the composition of the film base.

This publication will help you understand the requirements to safely handle, store, transport, and destroy cellulose nitrate-based films.



There are several methods to identify a film base.

You can prepare and analyze a sample of a film base by infrared absorption through an analytical laboratory using the procedure outlined in ISO 10682. Another test to distinguish nitrate film from safety film is to punch or cut a 1/4-inch diameter sample from the film and place it in a test tube or small bottle containing trichlorethylene. You will need to shake the liquid to ensure that the sample is completely immersed. Cellulose nitrate films will sink in the liquid and safety films will float to the surface. Cellulose nitrate films that have started to deteriorate may change density and may not sink in the trichlorethylene. Always perform this test in a well ventilated area to minimize exposure to trichlorethylene. Dispose of used trichlorethylene as a hazardous waste.

## DETERIORATION

In addition to the inherent hazards associated with the flammability of cellulose nitrate film, decomposition of the film also can present safety concerns during its storage, handling, transportation, and destruction. The deterioration of cellulose nitrate films can be divided in to five distinct stages:

Stage 1	Film has an amber discoloration with fading of the image. Faint noxious odor. Rust ring may form on inside of metal film cans.
Stage 2	Emulsion becomes adhesive and the film tends to stick together during unrolling. Faint noxious odor.
Stage 3	Portions of the film are soft, contain gas bubbles, and emit a noxious odor.
Stage 4	Entire film is soft and welded into a single mass, the surface may be covered with viscous froth, and a strong noxious odor is given off.
Stage 5	Film mass degenerates partially or entirely into a shock sensitive brownish acrid powder.

Deteriorated films in the first two stages are photographically reproducible. Unless you have expertise in determining the characteristics of nitrate films in various stages of decomposition, do not unroll the films.

For help determining the historical value of any material on nitrate base, contact a local historical film association, or one of the following:

Library of Congress  
Motion Picture, Broadcasting and  
Recorded Sound Division  
Washington, D.C. 20540-4800  
Phone (202) 707-5840  
Fax (202) 707-2371

National Archives and Records  
Administration at College Park  
8601 Adelphi Road  
College Park, MD 20740  
Phone (301) 713-6700  
Fax (301) 713-2371

Federation of International Film  
Archives (FIFA)  
FIFA Secretariat  
rue Franz Merjay 190  
1180 Bruxelles/Brussels  
Phone 32-2-343-06-91  
Fax 32-2-343-76-22

## SAFE HANDLING

As cellulose nitrate film decomposes, it can release nitric oxide, nitrogen dioxide, and other gases. These vapors will accelerate the decomposition of the remaining film base. Depending on the airborne concentration, vapors from decomposing film may be irritating to your eyes, nose, and throat. Providing adequate ventilation reduces the airborne concentration of the vapors and ensures that exposure limits established by the Occupational Safety and Health Administration (OSHA) or the American Conference of Government Industrial Hygienists (ACGIH) will not be exceeded.

To avoid contact with your skin and eyes, and to reduce the possibility of injury, *always* wear impervious gloves, such as rubber or neoprene, and eye protection when handling decomposing cellulose nitrate film.

## PRESERVATION AND STORAGE

Because cellulose nitrate films are flammable and there are decomposition concerns, you need to store and manage them in a safe manner that limits decomposition. You can preserve or duplicate cellulose nitrate films until the third stage of decomposition. Cellulose nitrate films that have reached the third stage of decomposition, or that have no historical value, should be destroyed at an authorized facility.

## STORAGE

Choosing a storage facility for cellulose nitrate films depends on the amount of film to be stored.

For *short-term storage*, you can use approved film cabinets for storing up to 750 pounds of film (equal to 150 1000-foot rolls). Use vaults for *longer-term storage* of amounts up to 750 pounds. Always store amounts over 750 pounds in vaults. Be sure to segregate cellulose nitrate films from other film storage areas.

For extended-term storage (for preservation of material having permanent value), store in archival cabinets or vaults that contain individual compartments and allow for decomposition gas venting.

Do not exceed 70°F inside the storage vault, and maintain the relative humidity below 50 percent. For long-term storage requirements, store the film at 35°F at 20- to 30-percent relative humidity.

Refer to the design specifications for film cabinets and vaults, including materials of construction, maximum capacity, venting, and sprinkler requirements found in NFPA 40, Chapter 4. You should also check your local fire code for additional film storage requirements.

In addition to cool and dry storage, Molecular Sieves are recommended for storage of all cellulose nitrate films. You can promote extended keeping and preservation of cellulose nitrate films with the placement of Molecular Sieves inside the film storage container. These sieves scavenge and catalytically decompose the gases that are generated during the storage of cellulose nitrate films and retard the degradation reactions. Molecular Sieves are available from FPC, 6677 Santa Monica Boulevard, Los Angeles, California 90038, (800) 814-1333 or (213) 468-1574.

Exposure to temperatures in excess of 185°F accelerates decomposition of these films. While they deteriorate, nitrate-based films can develop pressure and heat in the film can, especially when the can is taped closed. Contained gases and heat can lead to spontaneous combustion. Therefore, it is recommended that you store cellulose nitrate films in painted or tin-plated metal cans with loose lids. Do not tape the lids or use tight-fitting lids unless you are using Molecular Sieves.

Decomposition gases (powerful oxidizing agents) can also react with nearby acetate and polyester base films, so you will need to store cellulose nitrate films in a separate area. The decomposition gases can also promote decomposition of nearby cellulose nitrate films. If your cellulose nitrate films need to be stored, but have started to deteriorate, you must store them in an area that is separate from other cellulose nitrate film storage areas.

Store cellulose nitrate films in vaults in single or double roll containers or in approved shipping containers. You will need to examine the entire length of nitrate films prior to vault storage. If they are stored with temperature and humidity controls, you should inspect nitrate films on a hand rewind machine annually. Where storage conditions are not controlled, you should examine films every six months, or more frequently in warm climates. Any nitrate films you find in good condition can be returned to the storage vault. Any films that have progressed to the third stage of decomposition need to be destroyed at an approved facility.

## PROJECTION

You need to exercise care when attempting to project cellulose nitrate films. Cellulose nitrate motion picture films may be brittle and shrunken. Do not attempt to unroll or project a cellulose nitrate film unless you are thoroughly familiar with its physical characteristics. Improper projection can damage or destroy the film.

Because of the potential fire hazards, the projection of cellulose nitrate films is not a common practice. You should project cellulose nitrate films only in specially designed enclosures using projectors with air cooling systems. (Refer to design specifications in NFPA 40, Chapter 6.) Projection booths in older theaters were typically constructed with thick concrete walls, large steel doors mounted on rolling tracks, and explosion relief panels. Specialized projectors with fire prevention rollers were also used.

Since decomposition is accelerated with high temperatures, projecting cellulose nitrate film *without* air cooling systems will advance the decomposition stage. Therefore, do not return film that was exposed to high temperatures to your storage vault for long-term storage. You can reprint your film onto safety film and then send the cellulose nitrate film to an authorized facility to be destroyed.

## REPAIR AND DUPLICATION

Cellulose nitrate film repair and duplication services are not commonly offered. The following companies that provide these services are listed for your convenience but do not constitute a recommendation or endorsement by Kodak:

HFC Rejuvenation  
826 Seward  
Hollywood, CA 90038  
(213) 462-1971

ADF/Photogard/Durafilm  
Film Coating Laboratory  
1015 North Cahunga Blvd.  
Hollywood, CA 90038  
(213) 469-8141  
(Cleaning & physical repair only)

Cinema Arts Inc.  
P. O. Box 70  
South Sterling, PA 18460  
(717) 676-4145

Cine-Tech  
920 Allen Ave  
Glendale, CA 91201  
(818) 242-2181

YCM Labs  
312 West Burbank Blvd.  
Burbank, CA 91506  
(818) 843-5300

Film Technology Company, Inc.  
726 North Cole Ave.  
Hollywood, CA 90038  
(213) 464-3456

## TRANSPORTATION

Cellulose nitrate films that are shipped to a facility for storage, projection, duplication, or repair must meet special transportation requirements. Cellulose nitrate-based films are considered *hazardous materials* (dangerous goods) by the United States Department of Transportation (US DOT).

You must include one of the following descriptions on shipping papers that accompany the film, depending on mode of transport.

- For air transport (domestic or internationally) or domestic transport by ground within the United States (U.S.): films, nitrocellulose base, 4.1, UN1324, III.
- For transport by ocean internationally: films, nitrocellulose base, class 4.1, UN1324, III.

Package your cellulose nitrate films so that each reel of film is packed in a tightly closed inner metal can, Polypropylene canister, or in an inner packaging of strong cardboard or fiberboard with cover held in place by adhesive tape or paper. The inner packaging must be packed in one of the following outer packagings:

Outer Packaging Description	Specifications
Steel Drum	1A2
Aluminum Drum	1B2
Plywood Drum	1D
Fiber Drum*	1G
Steel Jerrican	3A2
Wooden Box	4C1, 4C2
Plywood Box	4D
Reconstituted Wood Box	4F
Fiberboard Box*	4G

\* Outer fiberboard or solid plastic boxes and fiber drums must be limited to a single reel of not over 600 meters (1,969 feet) of film.

For ground and ocean transportation, packagings must meet the packing group III (three) performance standards. For air transport (domestic or international) packagings must meet the packing group II (two) performance standards.

The following mark and label must be kept together and affixed to the outer packaging (do not place on the top or bottom of package):

Mark: Films nitrocellulose base,  
UN 1324

Hazard Communication label:  
Flammable Solid

US DOT may also allow additional types of shipping containers for transporting cellulose nitrate films. PRC offers a container that is an acceptable inner packaging for nitrocellulose-based films. These containers are available from Plastic Reel Corporation of America (PRC), Brisbin Avenue, Lyndhurst, New Jersey 07071, (201) 233-5100

Cellulose nitrate films can be transported in aircraft within the maximum limit of 25 Kg (55 pounds) on passenger aircraft or 100 Kg (220 pounds) on cargo aircraft. Vehicles or other public conveyance used for the transportation of passengers can be used for the transportation of cellulose nitrate film. Transportation using underground trains or subways is prohibited.

Cellulose nitrate films that are shipped to a facility for storage, projection, duplication, or repair must be transported by a carrier that is authorized by US DOT.

## WASTE MANAGEMENT AND DESTRUCTION

Cellulose nitrate films that have reached the third stage of decomposition, or have no historical value, need to be destroyed properly. Since these films decompose rapidly under certain conditions and are flammable, it is important that you store and transport these materials safely.

### WASTE CLASSIFICATION

Once it is determined that a cellulose nitrate film needs to be destroyed, it is considered a waste. Under the Resource Conservation and Recovery Act (RCRA), all waste cellulose nitrate films should be classified as hazardous wastes. Cellulose nitrate film that is designated for destruction must be identified as a hazardous waste using all applicable Environmental Protection Agency (EPA) Waste Codes. The

following EPA Waste Codes may apply to cellulose nitrate film:

Stable cellulose nitrate films designated for destruction or those that are in one of the first two stages of decomposition should be classified as a hazardous waste using EPA Hazardous Waste Codes D001 and D003. Cellulose nitrate films that are in one of the last three stages of decomposition should be classified as a hazardous waste using EPA Hazardous Waste Codes D001, D003, and D011.

## HAZARDOUS WASTE STORAGE

All cellulose nitrate films that are marked for destruction need to be stored and transported under water.

You will need to place them in a steel or plastic drum that meets US DOT specifications, and cover the films with water. The water must be more than 25 percent by weight of the total weight of the films. (Water weighs about 8 pounds per gallon.) Be sure to take into account the weight of any film reels.

When a cellulose nitrate-based film is designated for destruction, and is, therefore, a hazardous waste, RCRA requirements may apply to your storage facility. Long-term storage may require a RCRA permit. When a cellulose nitrate-based film is determined to be a hazardous waste, you should send it to an authorized waste-treatment facility for proper destruction as soon as possible.

EPA Waste Code	Definition
D001	A material is defined as an <b>ignitable hazardous waste</b> if it is an oxidizer as defined under USDOT regulations. Nitrate containing materials are specifically defined as oxidizers under those provisions.
D003	A material is defined as a <b>reactive hazardous waste</b> if it is capable of detonation or explosive reaction when subjected to a strong initiating source or heated under confinement. Cellulose nitrate films meet this criteria; they will spontaneously ignite under elevated temperatures. The rate of combustion of nitrate films is about fifteen times that of wood, and the resulting intense fire is virtually impossible to control or easily extinguish.
D011	A material is defined as a <b>hazardous waste</b> possessing the characteristic of leachable toxicity for silver if, when exposed to the Toxicity Characteristic Leaching Procedure (TCLP), the material leaches > 5 mg/l (ppm) of silver. Typically photographic films do not leach > 5 mg/l of silver when subjected to the TCLP. However, during decomposition, it is likely that more silver may be present during leaching once the film has reached the third stage of decomposition. The TCLP can also be performed on a representative sample of a film to define its characteristics.

## HAZARDOUS WASTE TRANSPORTATION

The transportation of cellulose nitrate films is regulated by both the US DOT and the United States Environmental Protection Agency (USEPA). Cellulose nitrate-based films are considered *hazardous materials* under USDOT and *hazardous wastes* by USEPA.

You are required to include the Shipping Name, ID Number, Hazard Class, and Hazard Label on the shipping papers that accompany the films for destruction:

<b>Shipping Name</b>	Waste Nitrocellulose, wet with not less than 25% water, D001, D003, D011*
<b>Identification Number</b>	UN 2555
<b>Hazard Class</b>	4.1
<b>Hazard Label</b>	Flammable solid

\* Include EPA Waste Code D011 only for shipping those films that are in one of the last three stages of decomposition.

Package waste nitrocellulose-based films with not less than 25-percent water and label as a flammable solid:

Packaging	Specifications
Steel drum	1A1, 1A2
Plastic drum	1H1, 1H2

Waste nitrocellulose-based films must be transported by a carrier that is authorized by USDOT and USEPA to transport hazardous waste. A hazardous waste manifest and a Land Disposal Restriction Form must accompany the material during transport.

## DESTRUCTION

Once your cellulose nitrate film is determined to be a hazardous waste, you need to ship it to a treatment facility as soon as possible, following the transportation requirements outlined above.

The appropriate treatment technology for cellulose nitrate film is *incineration*. The incinerating facility is required to have an RCRA permit to treat all EPA Hazardous Waste Numbers associated with your waste. This includes D001, D003, and possibly D011, depending on the decomposition stage of the film.

There are many facilities in the United States that are permitted to manage these types of waste. The following companies provide transportation and waste treatment. This list is provided for your convenience and does not constitute a recommendation or endorsement by Kodak:

ENSCO, Inc.  
Lincolnshire, IL  
Corporate Sales Offices  
(708) 945-5700

Ross Incineration  
Grafton, OH  
(800) 878-ROSS

WTS, Inc.  
640 Park Place  
Niagara Falls, NY  
(716) 282-4100

## REFERENCES

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**MORE INFORMATION**

For more information about Kodak Environmental Services, visit Kodak online at	<a href="http://www.kodak.com/go/kes">www.kodak.com/go/kes</a>
For environmental or safety questions about Kodak products, services, or publications, call	1-585-477-3194
For questions about the safe handling of photographic chemicals or health-related information about Kodak products, call our 24-hour hotline at	1-585-722-5151
For questions concerning the safe transportation of Kodak products, call Kodak Transportation Services at	1-585-722-2400
If you have questions about Kodak products, call Kodak.	
In the U.S.A., call	1-800-242-2424, Ext. 19, Monday–Friday 9 a.m.–7 p.m. (Eastern time)
In Canada, call	1-800-465-6325, Monday–Friday 8 a.m.–5 p.m. (Eastern time)
In countries other than the U.S. and Canada,	contact your local Kodak representative, or your usual supplier of Kodak products.

- J-110 *Formaldehyde Use in Photographic Processing Facilities*
- J-111 *Determining Workplace Exposure to Formaldehyde*
- J-112 *Formaldehyde Emergencies*
- J-113 *About the OSHA Formaldehyde Standard*
- J-311 *Hazard Communication for Photographic Processing Facilities*
- J-312 *Personal Protective Equipment Requirements in Photographic Processing Facilities*
- J-314 *Indoor Air Quality and Ventilation in Photographic Processing Facilities*
- J-315 *Special Materials Management in Photographic Processing Facilities*
- J-316 *Emergency Preparedness for Photographic Processing Facilities*
- J-317 *Injury and Illness Management for Photographic Processing Facilities*

This publication is a guide to the Federal Health and Safety Regulations that apply to a typical photographic processing facility. Local or state requirements may also apply. Verify the specific requirements for your facility with your legal counsel.

**This publication is printed on recycled paper that contains 50 percent recycled fiber and 10 percent post-consumer material.**



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