INTERNATIONAL STANDARD

ISO 10356

First edition
1996-11-01

Cinematography — Storage and handling of nitrate-base motion-picture films

Cinématographie — Entreposage et manipulation de films cinématographiques à base de nitrate

Reference number
ISO 10356:1996(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 10356 was prepared by Technical Committee ISO/TC 36, *Cinematography*.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Cinematography — Storage and handling of nitrate-base motion-picture films

1 Scope

This International Standard specifies safety aspects for handling and storage of radiation-sensitive motion-picture films which do not comply with the requirements of ISO 543. This International Standard applies to all nitrate-base films which are or have been used in motion-picture photographic systems.

Compliance with the storage and handling conditions specified in this International Standard does not ensure protection of the film from deterioration nor reduce its safety hazards.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 543:1990, *Photography — Photographic films — Specifications for safety film.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 radiation-sensitive film: All kinds of radiation-sensitive camera, duplicating and printing films and also processed original films, duplicates and prints.

3.2 safety photographic film: Photographic film which passes the ignition time test and burning time test as specified in ISO 543.

NOTE — ISO 543, in specifying safety film, makes a primary distinction based upon requiring a long or infinite burning time for a sample in a specified test. Additional information is given concerning films whose composition is such that they may be expected to fail, or to give ambiguous results in, the burning test.

3.3 nitrate-base film; cellulose nitrate film: Radiation-sensitive nitrate-base film which fails the burning and ignition tests of ISO 543.

NOTE — Because of the precautions required for the safe handling and storage of nitrate-base film, all radiation-sensitive films that do not originally (as opposed to being transferred from some other film) carry the marking specified by annex B of ISO 543:1990 should be considered to be nitrate-base films until proven otherwise.

4 Composition (see annex A)

The composition of nitrate-base film is described approximately by the following contents, expressed as percentages by mass:

— cellulose nitrate (nitrogen content 11,5 % to 12,6 %)	70 % to 82 %
— plasticizer	5 % to 15 %
— photographic layers	5 % to 15 %
— gaseous components	1,5 % to 4,5 %

WARNING — Although the fundamental hazard of cellulose nitrate is flammability, which has been somewhat reduced by the addition of the plasticizer, it is considered an explosive in the sense of laws on explosives. Cellulose nitrate is easily ignited, has a low ignition temperature and a fast burning rate, decomposes even without access to air and during decomposition forms flammable and toxic gases which yield explosive mixtures with air. The decomposition is exothermic and autocatalytic and can lead to auto-ignition. Heating of cellulose nitrate in closed containers causes explosive decomposition.

5 Identification

The identification of nitrate-base films shall be carried out in accordance with ISO 543.

6 Legal requirements for handling

Handling of photographic nitrate-base films is regulated by laws covering explosives. The storage of these films is also regulated by laws covering chemicals.

During handling and storage, all relevant laws and regulations on safety aspects shall be observed. All working rooms shall be identified and marked accordingly.

7 Transportation

Transportation of nitrate-base film on the road, by rail, at sea and by air shall be in accordance with national and international regulations and laws (e.g. Dangerous Goods Regulation of the International Civil Aviation Organization).

WARNING — Nitrate-base film shall not be transported by mail.

8 Storage (see annex B)

Nitrate-base films are difficult to store because of their low chemical stability, although experience has shown that the onset of deterioration can vary over a surprisingly long period extending from one to several decades. The useful life depends not only upon the storage conditions but, in seemingly unpredictable ways, upon variables of prior history of the film.

Frequent use of nitrate-base film, involving spooling and unspooling with concurrent exposures of individual convolutions to full ventilation, has been observed to extend the useful life. Consequently, all films which are kept in archives shall be examined, cleaned and tested on an established schedule (see clause 9). If the film shows signs of deterioration, the subject matter should be preserved while the images remain useful, by duplication or copying to a safety film stock. The nitrate-base film shall then be destroyed. The deterioration cannot be reversed or arrested.

Rolls of nitrate-base film that have not yet deteriorated shall be placed in individual metal cans (aluminium or stainless steel) with fitted but unsealed closures until they can be duplicated to safety film. Storage rooms and chambers should contain only nitrate-base film. Good practice requires that the amount of film placed in an individual room be limited, for example, to a maximum of 50 000 m each. Storage rooms should be equipped with appropriate ventilating systems, fire sensors, water sprinklers, etc. so that any possible conflagration can be confined to that room. These rooms should be constructed and ventilated so that toxic and flammable fumes and gases cannot reach other rooms.

Recommended climatic conditions for storage are given in table 1.

Table 1

Storage	Maximum temperature		Relative humidity
	°C	(°F)	%
Short term 1)	25	(77)	25 to 50
Long term	2	(36)	20 to 30

1) For example, examination, cleaning or duplication.

NOTE — A lower relative humidity can delay deterioration of nitrate-base films and their emulsion images, including reducing the alteration rates of dyes in colour films. Lower relative humidity will also reversibly change the physical properties, making the film more brittle and subject to accidental damage. This effect can be reversed by providing a suitable period of acclimatization to relative humidities of 40 % to 50 % prior to unspooling. In any event, a suitable period of accommodation to room temperature should always be provided for all film stored at reduced temperature before handling the film.

9 Inspection (see annex B)

Regular inspections shall be made in order to recognize any deterioration as soon as possible. If nitrate-base film is stored under the conditions given in clause 8, the film should be inspected at least once per year, and preferably every three months.

The preferred method of inspection is accomplished by winding through the film so that the complete length is subjected to visual examination. At the same time, when first opening the container the inspector should be alert for typical odours of deterioration, which approximate a mixture of fetid pungency with faint fumes of nitric acid.

The very first indication of deterioration is an alteration of the image. Monochrome silver images develop spots (which can be extensive) of reduced density that also acquire an iridescent sheen. Thereafter, with further deterioration, the typical odour develops, followed by physical changes including inter-layer adhesion plus weakening of the emulsion and base.

Alternatively, an analysis of the relative degree of the nitrate-base deterioration can be performed. This analysis will only yield a qualitative measure of the film condition. The test should only be used to indicate the onset of irreversible deterioration of the nitrate base. See annex C for the test method using alizarin red or Congo red and the evaluation of results.

10 Destruction

Destruction shall be in accordance with any relevant laws and regulations.

Annex A
(informative)

Chemical stability of cellulose nitrate

The chemical stability of cellulose nitrate used for the manufacture of nitrate-base film is rather low. These films deteriorate slowly and continuously, even in a normal room climate. During deterioration, nitrogen oxide, nitrogen dioxide and other gases are liberated. In the presence of humidity, nitrogen dioxide forms nitric and nitrous acid which are strong oxidizing agents. If nitrogen dioxide cannot escape from the can, it reacts with cellulose nitrate and accelerates deterioration. This autocatalytic reaction causes problems because the degree of deterioration under all possible conditions is not proportional to the age of the film and often cannot be detected in a timely manner. Nitrate-base film which has been in good condition for years can deteriorate within a few months.

Annex B
(informative)

Further information on storage and inspection

The following five categories of decomposing nitrate-base film are described in reference [3] in annex D.

a) Amber discolouration (single spots or large parts of the emulsion) with fading of the picture image.

b) The emulsion becomes adhesive and film convolutions tend to stick together during unrolling.

c) Annular portions of the film rolls become soft, contain gas bubbles and emit a noxious odour.

d) The entire film roll is soft, its convolutions are welded into a single mass and frequently its surface is covered with a viscous froth. A strong noxious odour is given off.

e) The film mass degenerates partially or entirely into a brownish acid powder.

Deteriorated film in categories a) and b) is photographically reproducible. In category c) only small portions may be reprintable. Films in categories d) and e) are useless and should be destroyed without further consideration.

It should be noted that the maximum flammability-hazard occurs for categories b) and c). By the time the film reaches category e) it has lost virtually all of its nitrate groups, and its flammability has then been reduced to approximately that of the cellulose itself, i.e. comparable to the flammability of paper.

The different deterioration speeds of nitrate-base film cannot be explained completely, although many factors are known which influence the stability. These are

— inner stability and degree of purity of the cellulose nitrate;

— keeping temperature – the deterioration speed doubles per 5 °C (9 °F) temperature increase;

— humidity content of the film;

— content of nitrogen oxides in the film;

— acid gases from the air.

Although fading of the image and the occurrence of spots can be caused by residual processing chemicals, there are no indications that these residues accelerate the deterioration of cellulose nitrate.

A single piece of nitrate-base film burns with a bright yellow flame if sufficient air is available. The gaseous reaction products are colourless and not toxic. They consist mainly of nitrogen, carbon dioxide and water vapour.

If there is not enough air available for complete combustion, and this is normally the case for film in rolls, the film burns with or without flames and generates large amounts of thick yellow fumes.

WARNING — These fumes are very toxic and can give explosive mixtures with air.

As an indication of what gaseous products can be anticipated, table B.1 gives those found in one specific set of conditions for thermal decomposition (reference [4] in annex D).

Table B.1

Compound	Concentration % (V/V)
Nitrogen oxide	1 to 8
Nitrogen dioxide and tetroxide	7 to 9
Carbon monoxide	48 to 59
Carbon dioxide	21 to 25
Hydrogen	1 to 3
Methane	1 to 3
Hydrogen cyanide	Traces

During total combustion of nitrate-base film, between 0,2 m^3 and 0,3 m^3 of gas per kilogram of film are produced at room temperature and pressure. At flame temperature, the volume increases to about 2,5 m^3 per kilogram of film.

The calorific value of nitrate-base film corresponds to the value of wood (about 14 000 kJ/kg to 19 000 kJ/kg). Since nitrate-base film burns 15 times faster than wood, the temperature increases much more rapidly.

WARNING — A nitrate-base fire is nearly impossible to control and cannot be extinguished with normal fire-extinguishing agents.

Annex C
(informative)

Method for determining the nitrate-base stability of motion-picture film using alizarin red C or Congo red

C.1 General

The essence of the method lies in determining a time during which the colour of an indicator paper will change under the action of nitric oxides evolved in heating a nitrate-base film sample.

Alizarin red C or Congo red are used as an indicator.

C.2 Preparation for analysis

C.2.1 During visual examination of nitrate-base film materials, two samples of diameter 6 mm ± 0,5 mm are cut out from each (part) roll.

C.2.2 A solution in water, of alizarin red indicator (0,05 %) or of Congo red indicator (0,2 %), is prepared.

C.2.3 The indicator paper is prepared as follows. Strips of filter paper are immersed in the solution in water of the indicator. The strips are then dried and stored in dark-glass pots with ground stoppers.

C.3 Analysis procedure

A film sample is placed in the bottom of a test-tube (capacity 10 ml) with a ground stopper. An indicator-paper strip is wetted in a water solution of glycerine (two parts glycerine per one part of distilled water) and wrapped around the stopper so that the paper extends 3 mm to 5 mm beyond the lower edge of the stopper. The test-tube with the sample is tightly plugged by the stopper wrapped with the indicator paper, and placed in a preheated air or glycerine bath held at a constant temperature of 130 °C to 136 °C until the colour of the indicator paper changes, for not more than 3 h.

The time is measured from the moment the test-tube is immersed in the constant-temperature bath to the moment when the colour on the tip of the indicator paper is changed.

When using alizarin red C indicator paper, it becomes discoloured; when using Congo red indicator paper, it changes from red to blue. Use of the Congo red indicator paper gives a more clearly defined moment of colour change and gives more reliable analysis results.

C.4 Interpretation of test results

The action to be taken is determined from table C.1. It should be noted that the analytic method described in C.3 is for qualitative analysis only. Any results requiring more than 1 h for the alizarin red indicator or more than 20 min for the Congo red indicator should be considered only as indicating that the film has no signs of base deterioration at the time of analysis. Inspection at the interval given in table C.1 or at a maximum interval of one year should continue as described in clause 9.