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Cinematography — Care and preservation of magnetic audio recordings for motion pictures and television

Cinématographie — Soins et préservation des enregistrements sonores magnétiques pour la cinématographie et la télévision

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Foreword

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Annexes A and B of this International Standard are for information only.

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Cinematography — Care and preservation of magnetic audio recordings for motion pictures and television

1 Scope

This International Standard recommends storage conditions for stabilization and preservation of magnetic audio recordings for motion-picture and television production.

It recommends the desirable storage conditions for magnetic audio recordings, as they may remain in library or vault storage between periods of intermittent reproduction or duplication.

It describes the care and handling of magnetic media intended to be introduced into, or removed from, storage.

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 edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ANSI/NAPM IT9.11-1993: *American National Standard for Imaging Media - Processed Safety Photographic Films - Storage.*

3 Storage hazards and concerns

Useful and acceptable reproduction of records removed from inactive storage requires attention to, and precautions against, all three of the following hazards: chemical degradation, physical distortion, and magnetic corruption [2, 3, 10, 11, 23]. Analog and digital recordings are on media with the same susceptibilities to chemical degradation and physical distortion. They do respond somewhat differently to magnetic corruption effects. The recommendations for storage conditions minimize each of these risks.

4 Summation of storage recommendations

4.1 Desired useful life of the recordings

4.1.1 Medium-term storage conditions

Storage conditions suitable for the preservation of recorded information for a minimum of ten years.

4.1.2 Extended-term storage conditions

Storage conditions suitable for the preservation of recorded information having a permanent value.

4.2 Recommended storage environments

Atmospheric temperature and humidity conditions for magnetic media storage are summarized and tabulated in table 1.

Table 1 — Storage conditions

	Medium-term	Extended-term
Equilibrium temperature, °C	23 max.	20 max.
Equilibrium relative humidity, %	20-45	20-30
Alternative 1: Temperature, °C	—	15 max.
Alternative 1: Relative humidity, %		20-40
Alternative 2: Temperature, °C		10 max.
Alternative 2: Relative humidity, %		20-50
Physical status:		
Winding	Co-planar	Co-planar
Enclosure	Protective	Protective
Roll orientation	Vertical	Vertical
External magnetic field		
DC: Oe	50 max.	50 max.
AC: Oe	10 max.	10 max.

5 Derivation of recommended storage conditions

The values in table 1 have been derived from the extensive practical experience with photographic films, as recommended by ANSI IT9.11 for the minimization of various degradations in monochrome photographic films. Most of the same polymers and modifiers are the major components of magnetic media. Existing data on magnetic media show that the two media are subject to the same degenerative reactions, with reaction rates that are similarly controlled by storage conditions [10, 11, 23, 30].

5.1 Application of the recommendations of table 1

5.1.1 Cycling

Cycling of temperature and/or humidity increases the severity of the storage conditions, and should be minimized.

5.1.2 Environmental purity

Control of air-entrained solid particles and gaseous impurities such as sulfur compounds, acidic vapors, ozone, peroxides, nitrogen oxides, ammonia, etc. are observed to accelerate chemical degradation.

5.1.3 Alternative storage recommendations

For extended-term storage, the three correlated temperature/humidity environments of table 1 provide essentially equivalent protection to the media. The choice among the three may be based upon convenience and existing structures.

6 Chemical stability

The stability of the organic carrier-matrix bearing the magnetic particles must hold the composite in its as-recorded structure to maintain the reproducibility of the record. Although specific audio magnetic records may incorporate additional chemical compounds not normally found in processed photographic films, it is perhaps fortunate that the chemical stabilities of the major components are controlled by the same environmental factors, thereby justifying parallel recommendations.

6.1 Moisture content and temperature of the media

All of the studies on chemical stability confirm that it is the precise moisture content and temperature of the actual media that controls the stability [2, 10]. When first placed in storage, the media may require considerable time to equilibrate to the surrounding storage environment.

6.1.1 Equilibration rates

A compact roll of tape or film can achieve temperature equilibrium with its environment rather quickly, but can achieve moisture equilibrium only by the slow molecular diffusion of moisture into or out of the face of the roll, all the way to the midplane of the tape or film [32].

6.1.2 Media enclosures

Media in storage should be in a protective enclosure or in a cassette. Such enclosed recordings will require even more time to achieve a different equilibrium relative humidity.

6.2 Nature of chemical instabilities

6.2.1 Polymeric hydrolysis

A major chemical degradation mechanism for most of the organic compounds present, both in photographic films and in magnetic recording media, is hydrolysis paced by the moisture content and temperature of the medium and possibly also catalyzed by some industrial pollutants[1)] [3, 4, 10, 28, 29].

6.2.2 Magnetic particle chemical stability

The inorganic magnetic materials in the media may include oxides of extended thermodynamic stability, or metallic elements potentially subject to oxidation which is also facilitated by increased moisture content and/or increased temperature [23, 26, 27, 30].

6.3 Optimum extended-term storage

Inasmuch as the rate effects of temperature and of equilibrium relative humidity (i.e. actual moisture content of the media itself) upon chemical degradation are cooperative, it is desirable, when maximum useful life of the recordings is important, to attempt reconditioning of the media before storage and to store at the lower range of recommended relative humidities and temperatures.

7 Magnetic corruption

Magnetic recording is a reversible process and the magnetic pattern representing information in a record remains capable of alteration by subsequent exposure to an appropriate magnetic field.

7.1 Environmental effects on magnetic corruption

All mechanisms contributing to magnetic corruption increase in activity and significance with increasing temperature.

7.1.1 Temperature effect

The temperature recommendations of table 1 have been chosen for minimizing chemical degradation over several years storage. Elevated temperatures limited to several weeks, or even days, however, can induce magnetic corruption, and should also be avoided.

7.1.2 Thermal energy effects

Randomized distribution of thermal energy among the particles over time can, with some probability, assist additional particles to change their magnetic sense, possibly even as directed by the juxtapositioned fields of the recording itself

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1) The actual moisture content of the media, either photographic or magnetic, increases with increasing partial pressure of water in the atmosphere (the absolute humidity), and decreases with increasing temperature of the medium. For most materials of interest over temperature ranges near "room temperature," this relationship, by pure chance, correlates approximately with relative humidity of the atmosphere. Thus ANSI IT9. 11 and related guides recommend equilibrium relative humidity ranges.

7.1.3 Magnetic field effect

External magnetic fields provide an additional potential for magnetic corruption of the recordings.[2)]

7.1.3.1 External DC fields with a magnitude no greater than 50 oersteds (4 kA/m), acting upon audio magnetic records in storage, have generally shown no degrading effect upon analog or digital recordings.[3)]

7.1.3.2 External AC fields are capable of assisting a larger number of particles to change magnetization sense, and therefore the somewhat lower AC field level of 10 oersteds (800 A/m) should be observed.

7.1.3.3 External fields not only increase the level of the noise floor, but also increase the print-through effect (see 7.2.1). An external AC field has been shown to be particularly effective in accelerating growth in the level of the printed signal.

7.1.4 External magnetic fields

External magnetic fields are most frequently observed near motors and transformers (e.g. commercial building elevator installations). Most of these installations are localized and therefore the field intensity falls off rapidly with separation; a few feet of separation from the source may provide protection. External fields of a more unanticipated nature may be produced by audio speakers, by cabinet latches, by magnetized tools, etc.

7.2 Analog recording mode

Analog audio recordings strive for a signal-to-noise ratio of 60 dB-80 dB and are therefore most sensitive to low-level corrupted information.

7.2.1 Print-through is a significant problem in the storage of analog magnetic audio recordings. The imprinting field that is acting upon the most susceptible particles is coming from the adjacent layer of the recording itself. The "added noise" is thus not random but recognizable music or dialog, and therefore most distracting.

7.3 Digital recording mode

Digital audio recordings provide quality reproductions from magnetic signal-to-noise ratios of about 20 dB. Accordingly, the reputed insensitivity of digital recordings to magnetic corruption has some foundation, but since digital systems usually take advantage of higher information densities, and work close to the limiting ratio, the margin may not be as great as is generally assumed.

8 Physical distortion

Reproduction of magnetic recordings (as well as the original recording process itself) requires consistent, intimate contact of the magnetic head with the media surface. Physical distortions interfere with achieving this requirement and thus degrade the reproduction.

8.1 Plastic flow

The deformation thresholds for plastic materials such as magnetic recording media are greatly dependent upon time. The yield point stress, beyond which nonelastic and irrecoverable deformation occurs, will be nearly as high as the break stress for suddenly applied shock loads and may be nearly zero for stresses maintained over a period of years.

8.2 Quality of roll winding

Since the prior use of the recording may have resulted in an irregularly wound roll, a full-length rewind is desirable to provide a uniform roll before storage.

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2) The earth's magnetic field is of the order of one oersted (80 A/m) and is below the level of concern.

3) Magnetic flux meters reading in this range have recently become commercially available at prices an audio archive could consider. Most meters read in gauss (technically the field induced in the meter's sensor). This is numerically equal to the value in oersteds (technically the applied field) because of the design of the meter.

8.3 Tail-out storage

Magnetic records are preferentially wound tail-out for storage and should be rewound to head-out orientation immediately before use.

8.3.1 Inspection rewinding

Rewinding in itself is somewhat beneficial in relieving physical stresses and in countering some of the magnetic corruption.

8.4 Dimensional changes

The plastic materials in magnetic recording media show a dimensional increase with the absorption of moisture, as well as with the increase in temperature, potentially inducing plastic flow and its resultant physical distortions. For most of the formats, the thickness direction has the highest coefficient and shows the greatest change. Temperature changes equilibrate rapidly and thus result in relatively uniform changes in inter-layer pressure. Moisture (equilibrium relative humidity) with slow equilibration, however, produces sustained dimensional differentials. Thus, when a tightly wound roll is subjected to a relative humidity gradient such that the exposed edges of the medium condition rapidly while the midplane may require weeks or months, non-uniform physical distortion may result.

8.5 Shrinkage

Magnetic media may suffer some permanent shrinkage over time from loss of volatile components and/or release of manufacturing-induced strains. This is normally of insignificant magnitude if it is not accompanied by other physical distortions.

8.5.1 Perforation pitch

For magnetic films perforated for compatibility with motion-picture systems, shrinkage will change the perforation pitch. Unless accommodation is made in the reproducing transport, the level of flutter may be increased.

9 Preparation of media for storage

9.1 Record form

Magnetic audio recordings may exist in roll form or in cassette form, with the media already enclosed by the shell of the cassette. Media in roll form should be placed in a protective enclosure selected from one of the following compositions: coated steel, aluminum, polyester plastic, polyethylene or polypropylene plastic, or acid-free paperboard.

9.2 Orientation during storage

It is preferable for magnetic media to be stored with the rolls in a vertical orientation. If the media is not on a substantial reel, or within a cassette, the rolls should be supported by their hubs to eliminate asymmetric pressures on the rolls.

9.3 Actual media moisture content

During the generation and prior history of the audio magnetic recordings there may have been significant exposure to higher humidities, with some equilibration, expedited by multiple transporting (as in a reproducer). Recognizing the very slow rates of moisture equilibration in media rolls not in active use, any magnetic media which may enter a storage vault of lower relative humidity than the equivalent relative humidity of the media itself may take many months to equilibrate to vault conditions.

10 Removal of media from low-temperature storage

10.1 Moisture condensation

To minimize the formation of moisture condensation on the media or its enclosures, material removed from the low temperatures of extended-term storage should be equilibrated within its external package for at least 24 h at medium-term conditions. The maximum temperature and humidity gradient during transition should not exceed 10 °C/h or 10 % R.H./h.

10.2 Pre-conditioning

The same pre-conditioning period should be applied to media received for storage that is presumed to have been exposed to low temperatures during transportation, etc.

10.3 Physical effects of low-temperature storage

Rolls that have been stored at low temperatures will be found to be somewhat looser than prior to storage, due to the dimensional changes noted in 8.4. Additional care in handling may be required.

11 Preparation for reproduction after storage

Reproduction of archived recordings should only be attempted after a thorough check of the reproducing transport. Useful and acceptable reproduction from records so preserved further demands that the anticipated reproduction process be in conformance with the essentials of good practice.

11.1 Transport maintenance

The reproducing transport should be properly serviced and clean, particularly on all surfaces contacting the medium.

11.1.1 Alignment

The mechanical alignment should be checked so that the medium is properly transported and guided and physical distortions are not induced.

11.1.2 Demagnetization

Prior to loading the recorded medium, the magnetic heads should be demagnetized.[4] The entire media path should be checked for residual magnetism and demagnetized as needed.

11.1.3 Calibration

The reproducing transport should be checked with a suitable test and calibration recording to determine that it is performing according to the appropriate standard.

11.2 Observed performance

The archived recording should be observed during reproduction to verify that it is free from physical distortions and other potentially degrading characteristics.

11.3 Working copies

If repeated usage of the archived recording is anticipated, a working copy should be prepared and used for the continuing operations.

12 Preservation of deteriorating recordings

Whenever an archived recording is found to show any signs of quality degradation, the best possible copy should be made immediately.

4) Some of the more recently designed magnetic transports provide for automatic head demagnetization as an integral part of the shut-down procedures.

Annex A
(informative)

Additional data

Audio magnetic recordings for motion-picture and television applications are of continuing interest and importance. They exist on a variety of media types, with earlier records in the analog mode while more recent records may be either analog or digital. This International Standard examines the limits to useful life of such recordings, and recommends practices to optimize their future performance.

A.1 Structure of magnetic media

In figure A.1, the structural components that provide media integrity and performance are identified. While it is sometimes possible to combine the function of two components within a single physical entity, each of the functions is essential and must survive without failure.

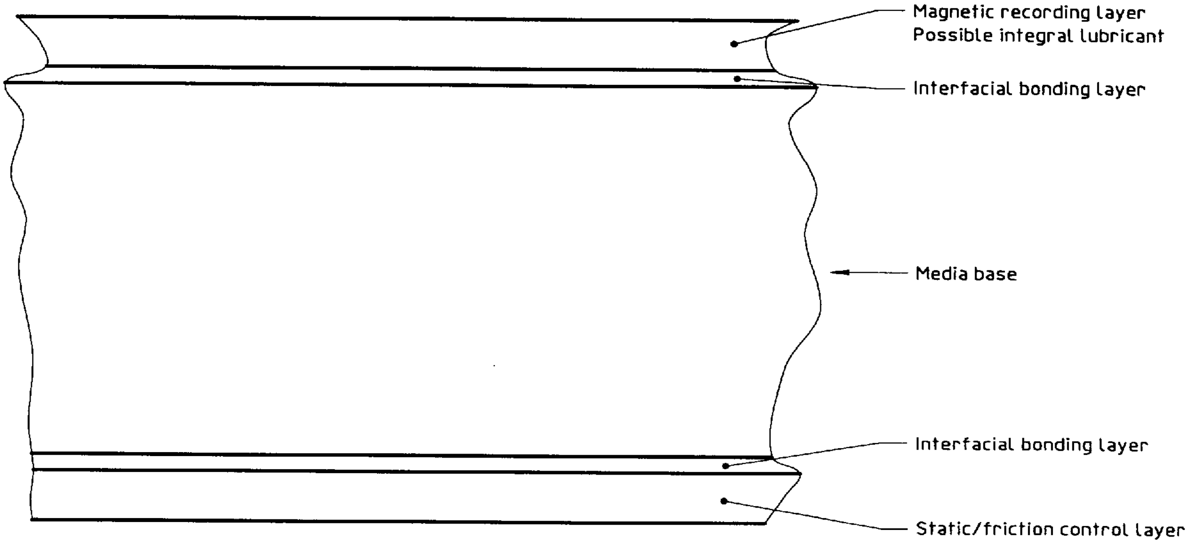

Figure A.1 — Cross-section of magnetic recording media (schematic)

A.2 Diversity of magnetic audio records

For the media of interest in audio recording, both as a final audio release and as audio recorded or presented in conjunction with images, many compositions of these structural components are encountered. Table A.1 identifies most of those found in archives, along with those employed in the recordings on current media.

Table A.1 — Diversity of analog audio magnetic records

Format	Nominal total thickness		Magnetic medium					
	mils	microns	Oxide, standard bias	Oxide, medium bias	Chromium dioxide	Oxide, high bias	Metallic particle	Metallic film
Tape								
Polyvinyl	2,5	63	*					
Acetate	1,4	36	*	*	*		*	
Acetate	2,0	51	*	*	*		*	
Polyester	1,3 – 1,5	33 – 38	*	*	*	*	*	
Polyester	1,9 – 2,2	48 – 56	*	*	*	*	*	
Audio cassettes								
Polyester	0,4 – 0,6	10 – 15	*	*	*		*	*
Polyester	0,7 – 1,2	18 – 30	*	*	*		*	*
Full-coat magnetic film								
Acetate	5,6	142	*	*				
Polyester	3,6 – 3,8	91 – 96	*	*				
Polyester	5,6 – 5,7	142 – 145	*	*				
Striped magnetic film								
Acetate	5,6 – 6,3	142 – 160	*	*				
Polyester	5,4	137	*	*				
Striped composite prints								
Acetate	6,8	173	*					
Polyester	5,9	150	*					

A.3 Statistical distribution of deterioration rates

Magnetic recording media have been produced over the years by a number of manufacturing entities. The components have continued to be members of the same chemical and physical families, but minor variations have at times been incorporated. These initial distinguishments, in conjunction with various prior histories before selection for archiving, have increased the diversity of the population. It has been observed that corresponding differences in the rates of degradation have been observed [23]. The storage conditions recommended in table 1 have been shown to provide the best assurance, but occasional records may show earlier decomposition.

Annex B
(informative)

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