Fundamentals of AV Preservation

CHAPTER 1

CARE AND HANDLING OF AUDIOVISUAL COLLECTIONS

Northeast Document Conservation Center | NEDCC
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PREFACE

NEDCC is pleased to offer the Fundamentals of AV Preservation textbook for self-study to anyone with internet access. An HTML version is available online at *www.nedcc.org/av-textbook*, and downloadable PDFs can be found at *www.nedcc.org/publications*. Covering the core topics in caring for and reformatting audiovisual collections, this resource supports cultural heritage professionals in their efforts to steward audiovisual materials.

- Chapter 1: Care and Handling of Audiovisual Collections
- Chapter 2: Inventory and Assessment
- Chapter 3: Planning, Preparing, and Implementing Reformatting Projects
- Chapter 4: Managing Digital Audiovisual Collections
- Chapter 5: Disaster Preparedness and Response
- Glossary

Credits

The content for each chapter of the Fundamentals of AV Preservation textbook was created in 2017 by staff members of AVPreserve (now AVP) and edited by NEDCC staff members. The textbook served as the foundation of a multi-session, instructor-facilitated online course launched by NEDCC in 2017. The development of the course and textbook were subsidized by the National Endowment for the Humanities, and in 2022, additional NEH funding supported the transformation of the HTML textbook into downloadable PDFs.

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CHAPTER 1

CARE AND HANDLING OF AUDIOVISUAL COLLECTIONS

by Chris Lacinak, President, AVPreserve and Rebecca Chandler, Consultant, AVPreserve

THIS CHAPTER DISCUSSES THE CARE AND handling of physical audiovisual collections, which is an essential component of any preservation strategy. While proper care and handling serve as great tools for combatting degradation and damage, they do not address obsolescence in any way. It is clear that preservation and access of information recorded on physical audiovisual media requires digitization. It is also clear that the need is great and that prioritization for digitization over a longer period of time is the reality for many organizations. Until digitization can occur, proper care and handling of the original recording is the primary mechanism of preservation and helps ensure that the information recorded on the physical media will be able to be digitized with the highest degree of integrity possible.

However, even following digitization the need to care for the physical media containing the original recording persists, as it plays an integral role in the overarching preservation strategy of the recording. There are multiple scenarios that may lead to utilizing that physical media post-digitization. These could and have included disasters resulting in loss of the digital copies, critical errors in digitization or digital preservation implementation, or technological improvements that yield significantly better reproduction and digitization. Central to preservation is the concept of risk management and proper care and handling of the original recordings, before and after digitization, which greatly mitigates the risk of loss.

SECTION 1: CARE AND HANDLING

Physical care

There are two primary components that make up proper care and handling: storage of the objects and handling of the objects by staff who interact with the media. Storage factors are explored in depth in our Preservation 101 guide[1] and will be related to specific AV materials throughout the course of this chapter.

Many materials may end up in multiple storage circumstances throughout their life. The more time they spend in advantageous conditions, the greater the chance of significantly slowing down degradation mechanisms.

There are a number of general practices that improve the longevity of media collections. These include limiting exposure to:

- Heat
- Humidity
- Liquids
- Dirt, dust, and particulates
- Light
- Mold and fungus
- Pollutants and contaminants

1 https://www.nedcc.org/preservation101/session-2/2storage-environment

You should also be careful to avoid:

- Handling portions of the media where the signal is recorded without appropriate gloves
- Putting weight on the media
- Leaving media unhoused
- Using machine transports that are not functioning properly
- Using machine transports that have not been properly calibrated and aligned

Storage approaches specific to media types will be addressed later in this chapter.

Handling of materials

Throughout an object's time held within your archive, it is likely to be handled by multiple people for different reasons. At each of these points, how the materials are handled and treated has implications for the well-being of the recording stored on the original media. Salient activities performed in the life of an object that involve handling include objects being:

1. Accessioned
2. Moved
3. Described and assessed
4. Inspected, surveyed, and inventoried
5. Retrieved and returned to storage for collection management or patron reasons
6. Treated and repaired
7. Reproduced and digitized

Determining how an object should be stored and handled is dependent on the physical and chemical composition of the media, as well as the way information is recorded onto and played back from the media. It is not critical to understand the finer details of every format and media type in your collections in order to properly care for them, but having a basic understanding will help bolster your knowledge of how to care for an object once you have properly identified the format. Understanding these aspects and knowing how to act on them is the subject matter of the remaining sections of this chapter. Please note that for the sake of simplicity and understanding, this text will focus on the most predominant material types and formats only, including magnetic media, grooved media, optical media, and film. Fringe media types and esoteric formats are not within the purview of this chapter.

Knowing your collection

When looking at particular physical audiovisual media, there are three primary characteristics that affect proper storage, care, and handling practices. These are carrier types, media types, and the method of reproduction.

Although this text presents a number of reasons to be cautious when handling media objects, it is also important to become comfortable with these items. Reading about how handling can cause damage is much different than experiencing it. If you have access to or can purchase disposable, non-unique material, try bending, stretching, scratching, tearing, and breaking it to become more familiar with the look and feel of these objects and the damage that can occur to them.

The following section is an overview of media objects likely to be held in your archive. Each media type's materials and associated preservation issues will be discussed, but specific format identification will be discussed in Chapter 2.

SECTION 2: GROOVED MEDIA

History

DISCS

Discs, also commonly referred to as records, have a long history spanning from the late 1800s with the introduction of Berliner discs to the present with the ongoing manufacturing of vinyl records. While the form has essentially stayed the same over time, there have been several variations in material composition and construction, method of recording, and recording specifications. For simplification, this text will focus on the three types of discs that you are most likely to encounter in collections: shellac, instantaneous, and vinyl.

Shellac discs were used in the earliest days of recording. Discs were originally recorded using an acoustic-mechanical method. Think here of the pictures you have undoubtedly seen of a group of musicians or a speaker in front of a horn.

The acoustic energy was captured by the horn which would move a diaphragm at the small end of the horn, attached to a cutter that would cut into the disc. This disc would then be replicated for commercial distribution; these discs were referred to as shellac. In the mid-1920s, the creation of the microphone led to the recording of discs using an electro-mechanical recording method, converting electrons to mechanical energy used to cut into the disc. It was also about this time that the industry involved in the creation of these discs standardized playback speed at around 78 **RPM**. Prior to this, speed varied quite a bit. Shellac discs are identifiable by their uniform thickness throughout the disc, their rigidness, and a matte finish when compared to vinyl and lacquer. The most common diameters are 10” and 12”. Although the distinction is made between acoustic-mechanically recorded and electro-mechanically recorded discs, this has little bearing on how these discs are stored and handled and despite the variance in recording method, they will share a common reproduction method.

In the 1930s, instantaneous discs were introduced, fulfilling the need to create a recording that could immediately be played back. They did not require a replication process and they were not intended for distribution. This spawned a plethora of documentary recordings, capturing everything from ethnomusicological field recordings to home recordings, interviews, oral histories, off-air radio recordings, and more.

Vinyl discs were introduced in the late 1940s. Similar to shellac recordings, an original is recorded and then used to start an intricate process that results in the creation of copies for distribution. Compared to shellac and instantaneous discs, vinyl is flexible, thin, and lightweight. A vinyl disc’s surface is softer, making it more prone to scratches.

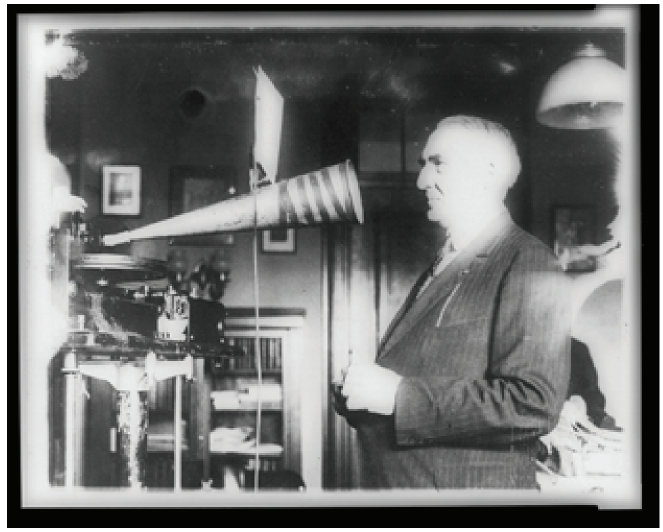
CYLINDERS

Cylinders date from the late 1870s with the invention of the phonograph and were common through 1929 when production ended in favor of discs. The composition of cylinders varies greatly within this time period—from tinfoil covered metal tubes to molded wax to celluloid (a type of plastic). The method of recording remained constant; however; cylinders, like early discs, were recorded using an acoustic-mechanical process. A standard cylinder is typically 2.25” in diameter and between 4” and 4.25” in length, but specialty sizes can range from 1.33” to 5” in diameter and 0.5” to 8” in length. Cylinders may or may not have a cardboard core.

FIGURE 1.1

President Harding speaking into recording apparatus.

Credit: Library of Congress https://www.loc.gov/item/96522821



Playback speed varies greatly depending on the manufacturer and technology for commercial recordings and the equipment and operator for home recordings. Rotation speeds for commercial recordings include 120 RPM, 144 RPM, and 160 RPM. Cylinders with differing diameters must be played back on a matching **mandrel**.

Materials and preservation risks

DISCS

Shellac discs have no significant degradation mechanisms under normal conditions and are a robust format in all regards except one. Their rigidity and composition make them prone to breakage through mishandling. Excessive pressure or dropping a shellac disc will almost certainly result in breakage.

FIGURE 1.2
Shellac disc.
Credit: AVP.

There are three main types of instantaneous discs that are found in collections. These are aluminum-based lacquer discs, glass-based lacquer discs, and aluminum discs. Glass-based lacquer discs replaced aluminum during World War II when the demand for metal became great.

FIGURE 1.3
Laquer disc.
Credit: AVP.

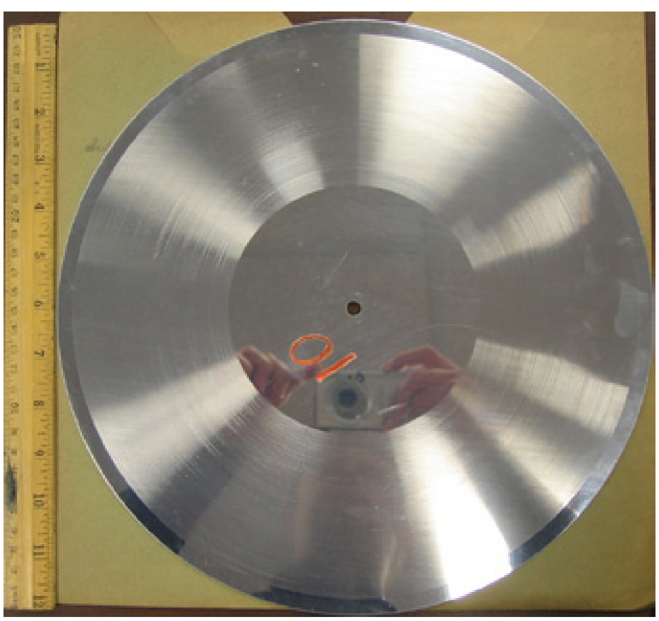


FIGURE 1.4
Laquer disc.
Credit: AVP.

Lacquer discs have multiple degradation mechanisms. Over time, the lacquer layer can undergo chemical and dimensional shifts that cause it to separate from the base glass or aluminum layer, leading to what is referred to as **delamination**.

FIGURE 1.5
Delaminated disc.
Credit: AVP.

Once delamination has occurred there is no way repair the damage; however, there are warning signs that can alert you in time to successfully transfer the signal on those discs about to suffer delamination. Early signs consist of a whitish film covering the disc, consisting primarily of palmitic acid. Palmitic acid is a chemical used in the creation of lacquer discs; this leaching out of the palmitic acid is a major contributor to delamination. At this stage, where the palmitic acid is leaching out, but the lacquer has not yet begun to crack, it may still be possible to have the disc cleaned by a professional and the signal transferred from the disc.

FIGURE 1.6
Palmitic acid, an early sign of delamination.
Credit: AVP.

Lacquer discs are also fragile and rigid, making them prone to breakage. This is particularly true for glass-based lacquers.

Aluminum discs do not tend to have degradation mechanisms, but they do have one issue that can manifest through mishandling and improper storage. The grooves cut into aluminum discs can be shallow due to the way they were recorded. Combined with the softness of aluminum, significant pressure against the side of an aluminum disc can make the grooves shallower than when originally recorded. This diminishes the integrity of the original recording and sometimes may render it unplayable.

Improper storage, care, and handling practices may result in the following disc issues, impairing reproduction:

- Matter such as dirt, dust, hair, and other particulates can scratch the surface of the disc, altering the groove or creating separation between the stylus and the groove.
- Fingerprints, where they exist on the surface of a disc, can speed up or cause degradation.
- A layer of white film (palmitic acid) covering the disc, indicating the beginning stages of delamination, which must be cleaned off before reproduction.
- Delamination, resulting in partial or total loss of the signal.
- Warping, causing audio artifacts during impact due to speed variation.
- Flattened groove walls from too much pressure on the side of the disc, resulting in distorted sound and potentially an inability to track the groove with a stylus.
- Breakage, resulting in partial or total loss of the signal.
- Scratches from improper handling and/or transport.

CYLINDERS

In general, cylinders are fragile, and care should be taken not to drop or bump them. Prior to 1902, when more rigid wax formulas were introduced, cylinders were typically made from brown wax. Brown wax cylinders are extremely soft and fragile, are prone to surface scratching and groove wear, and are susceptible to fungal growth. Home recordings made on brown wax are especially high risk; users often shaved off layers of wax in order to reuse the cylinders, making these particular cylinders extremely thin and prone to breakage. Improper storage and handling of these softer wax cylinders may also result in a warping of the grooved surface, resulting in sound artifacts due to speed variations.

Improper storage, care, and handling practices may result in the following cylinder issues, impairing reproduction:

- Matter such as dirt, dust, hair, and other particulates can scratch the surface of the cylinder, altering the groove, or creating separation between the stylus and the groove.
- Fingerprints, where they exist on the surface of a cylinder, can speed up or cause degradation.

- Warping, causing audio **artifacts** during impact due to speed variation.
- Breakage, resulting in partial or total loss of the signal.
- Scratches from improper handling and/or transport.

Reproduction methods

DISCS

Presently, there are two different ways that the sound recorded on discs is reproduced. The traditional method consists of using a turntable, otherwise known as a record player, which utilizes an electro-mechanical method of reproduction. A stylus of the appropriate size and shape is selected according to the groove dimensions. Any movement that the stylus makes which is not part of the actual recorded signal adds noise and distortion to the audio reproduction. Given the miniscule movements involved in this process, even a small amount of particulate matter or a scratch can significantly impact the resulting sound. It is easy to see how delamination, breakage, or significant scratches may make it impossible to play a disc back.

The other method that is used for reproduction involves scanning or imaging the groove. Once the image of the groove is captured, the mechanical variation is able to be identified and calculated. These calculated variations are then plugged into an algorithm that generates a digital audio file representing the originally recorded signal. This method is particularly useful when discs are damaged or degraded to the extent that a stylus would not be able to stay in the groove of a disc.

Reproduction via turntable and via imaging are significantly different, but the recorded signal in the original disc results in similar audio results when particulate matter, scratches and other things obscure the groove. Ultimately, careful storage and handling practices are important to the integrity of the content regardless of which reproduction method you choose.

CYLINDERS

Like discs, there are currently two playback mechanisms for cylinders: the traditional electro-mechanical method and the imaging method. First, a correctly sized mandrel must be chosen for playback; the diameter of the mandrel will correspond to the interior diameter of the cylinder. Then an appropriately sized and shaped stylus must be chosen based on the groove dimensions. As with discs, the movement of the stylus generates electrons and any additional movement caused by scratches or particulate matter will affect the sound.

Cylinders differ from most discs, however, in that their grooves are vertical as opposed to discs' lateral grooves. The vertically oriented grooves create hill and dales which must be imaged using 3D technology in order to obtain the information necessary to generate a digital audio file representing the originally recorded signal.

Best practices for storage and handling[2]

ENVIRONMENT

- Discs and cylinders should be stored at temperatures between 33 and 54 degrees Fahrenheit, with RH between 30%-50%. Temperatures should not fluctuate more than ±2 degrees within a 24-hour period. RH should not fluctuate more than ±5% within a 24-hour period.
- Discs and cylinders should be kept away from sources of heat, including sunlight or room lighting.

HOUSING

- Discs and cylinders should be stored on their edge or end so that they stand vertically. This will avoid pressure that may cause breakage, warping, groove wall flattening, or otherwise place undue stress on the surface of the disc.
- Discs should be in sleeves and housing that protect them from external elements and do not generate particulates or react chemically with the disc.

2 The storage and handling best practices used in this chapter are based on various ISO standards. The reality is that any improvement in environmental conditions will be beneficial to your collections.

- Cylinders should be removed from any original cardboard housings. These cardboard housings are known to foster mold growth in humid storage conditions.
- Cylinders should be stored in appropriate housings that protect them from external elements and do not generate particulate or react chemically with the disc. Cylinders should be housed in specially designed archival boxes containing a foam tube that fits within the cylinder, keeping the cylinder steady without allowing the grooves to touch the interior of the box.

HANDLING

- Handle the disc from the edges only. Do not touch the surface of the disc without using non-abrasive, non-shedding gloves.
- Handle the cylinder from the ends or interior only. Do not touch the surface of the cylinder without using non-abrasive, non-shedding gloves. To pick up a cylinder, insert two fingers into the cylinder and spread your fingers.

SECTION 3: MAGNETIC MEDIA

History

TAPE

The ability to record audio on magnetic tape in a consistent way first came on the scene in Germany in the late 1920s. It wasn't until the late-1930s that the tapes could be mass produced and the playback devices were stable enough for general use. The quality of recordings began quite poor but had improved dramatically by the early 1940s. However, it wasn't until after WWII that magnetic tape recorders made it to the United States. Singer and actor Bing Crosby heavily invested in magnetic tape technologies and helped to bring the medium to broadcast radio in the United States. Magnetic tape recordings were a huge improvement over the transcription discs that had previously been used in broadcast radio: they were of better quality and easier to edit.

Magnetic tape recording is built on the same basic concepts on which the telephone was created: mechanical sound waves are converted into electrical current, transported through cables, then converted back to sound waves. Magnetic tape recordings add an additional step —a magnetizing coil is used to record the signal. In the early days of magnetic tape recording, the signal was recorded onto paper coated with iron oxide; the paper was later replaced with the acetate and polyester base with which we are all more familiar.

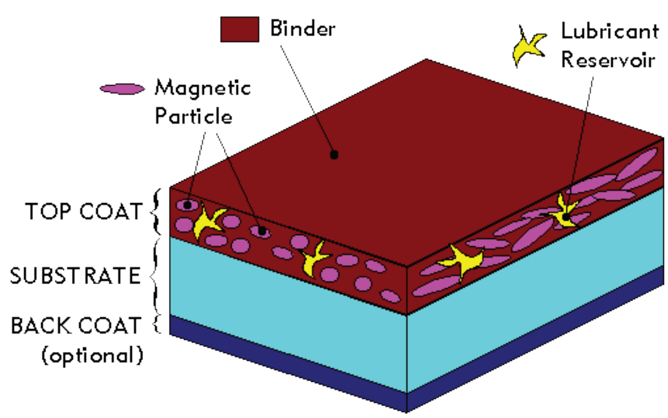
For all tape there is one side that contains the magnetic particles on which information is recorded. These magnetic particles are adhered either through use of a binder system or the **metal evaporated tape process**. The opposite side of the tape will either be the bare side of the **substrate** or a **back coat** that is added on.

Soon after the introduction of magnetic tape audio recordings to the United States, the same principle was applied to video. Video signals are similar to audio signals, but have a much higher bandwidth, meaning a lot more information must be recorded in order to properly reproduce the signal. This hurdle was overcome with the invention of the spinning recording head that allowed for much more information to be recorded and read. It wasn't until much later that further advancements and improvements were made so that the medium became compact and easy enough to handle that video was able to enter the home market.

FIGURE 1.7

Cross Section of Magnetic Tape.

Credit: The Commission on Preservation and Access and the National Media Laboratory, *Magnetic Tape Storage and Handling: A Guide for Libraries and Archives*, https://www.clir.org/pubs/reports/pub54/2what_wrong.



WIRE

Magnetic wire recordings actually pre-date magnetic tape recordings. They were first invented in 1898 and were meant to record dictation. Wire recording did not really catch on as a major format until the mid-1940s when technical improvements made it both better quality and more affordable. It began to be marketed not only for office use, but also for home recording. By the mid-1950s, however, magnetic tape recorders had caught up in quality and price and quickly surpassed the wire recorder in use.

Again, the recording method recalls the principles of the telephone. The electrical audio signal magnetizes the wire as it passes quickly over the recording head. The magnetized signal corresponds to the intensity and polarity of the original signal. During playback, the wire is run over the same head, but since there is no signal being supplied during playback, the changing magnetic field present on the wire reproduces the original signal.

MATERIALS AND PRESERVATION RISKS

The base materials for tape fall into one of four basic categories. These are acetate, polyester, PVC, and paper. Acetate, PVC, and paper will only be found on open reel audio. All audiotape housed in cassettes and all videotape is polyester based.

Paper-based tape is notable in look and feel and is somewhat rare to come across. The associated handling follows basic common sense regarding the sensitivities of paper-based materials and the possibility of tearing. Acetate can be identified by holding a reel of tape sideways between your eye and a light. If it is translucent then you are holding an acetate tape. If it is opaque, then it is either polyester or PVC.[3]

When put under excessive tension, acetate tape will simply break. Acetate that has degraded and become brittle will be prone to breaking more easily. Breaks in paper and acetate tape can be easily repaired using **splices**, but a significant number of breaks is a sign of an issue with the tape or with the playback machine and will cause notable audio artifacts. PVC- and polyester-based tapes, when put under excessive tension, will stretch and become

FIGURE 1.8

A reel of acetate tape will appear translucent when held sideways between your eye and a light.
Credit: AVP.

deformed resulting in audio artifacts, as well. For analog audio, stretching will cause audio artifacts. For analog videotapes, digital audiotapes, and digital videotapes, stretching can lead to artifacts or a total inability to retrieve a signal in the stretched portions. If the tape is visibly stretched, it can also damage the transport of the playback machine. An issue that primarily impacts polyester and PVC tapes is failure of the **binder system**. The most common problem that falls under this category of failure is known as **sticky shed syndrome**, which results in low cohesion and high friction during transport. When the tape is put onto a machine and wound or played back, sticky residue comes off onto the transport of the machine and the increased friction in the transport causes audio distortion upon playback. Excessive winding of a tape that experiences binder system failure can lead to stretching of the tape and edge damage.

Carrier types and preservation problems

Tape, whether audio or video, analog or digital, comes in two basic forms: open reel and cassette. Open reel tape has tape wound around a hub with **flanges** on the sides, with tape ranging in width from ¼” to 2”. Audiotape is sometimes stored on a hub with no flanges attached. This is referred to as a “pancake” and requires special

3 It is difficult to differentiate between polyester and PVC tapes. For the purposes of care and handling, their needs are similar, meaning you do not need to identify these to properly care for them.

attention because it is particularly prone to coming unwound.

Cassettes come in a range of sizes, typically housing tape widths from 1/8” to 3/4”. There are also cartridge formats that are more blockish in appearance, but the construction is more or less the same.

An issue pertaining primarily to audio open reel is that of degrading splices. This pertains primarily to audio open reel because it is rare for cassette-based formats to have splices and uncommon for video open reel to have splices.

FIGURE 1.9

A tape with sticky shed syndrome has left this sticky residue on the playback machine.

Credit AVP.

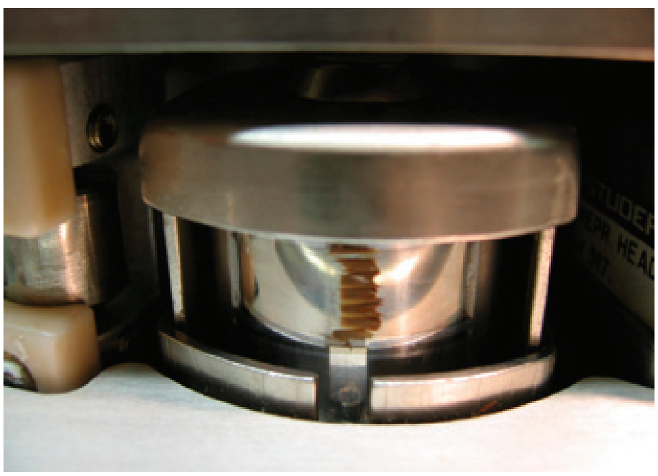


FIGURE 1.10

Diagram of a Tape Reel.

Credit: The Commission on Preservation and Access and the National Media Laboratory, *Magnetic Tape Storage and Handling: A Guide for Libraries and Archives,* https://www.clir.org/pubs/reports/pub54/2what_wrong/.

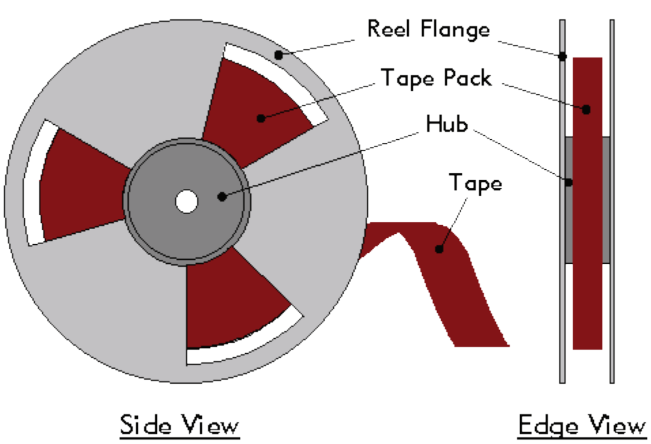


FIGURE 1.11

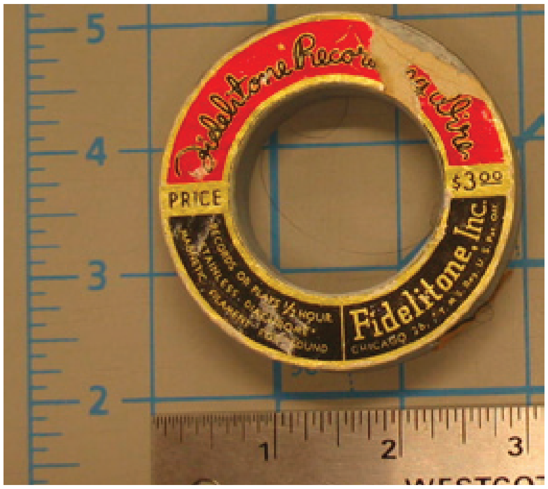
Unwound magnetic tape.

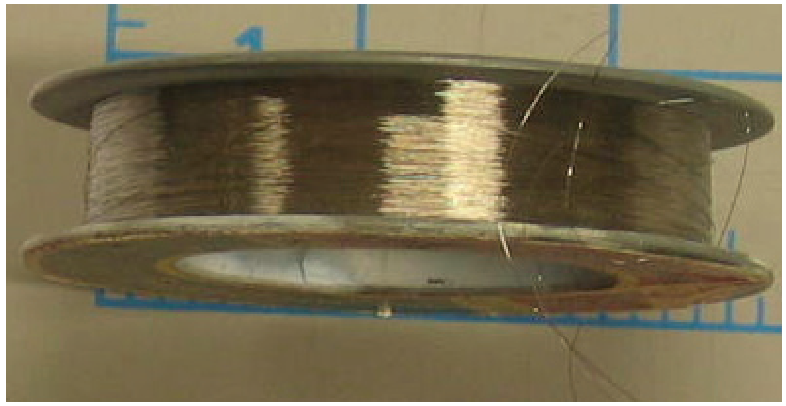
Credit: AVP.

If there are splices in video open reel they tend to be few in number. Audio open reel tapes on the other hand have been known to have anywhere from none to hundreds of splices. Issues with degrading splices can range from splicing tape that simply dries up and breaks to extruding adhesive, causing multiple adjacent layers to stick together.

Wire recordings are specific to audio and typically consist of stainless-steel wire that is between .004 and .006 inches in diameter wrapped around a spool. Spools of wire are commonly 3” in diameter and .75” wide, although these dimensions can vary depending on when and for which application the wire was made.

The wire itself does not have degradation mechanisms, as it is made of steel. The biggest risk factor to the physical state of wire recordings is becoming tangled in transport, which can lead to breakage or the need to cut out sections in order to resolve the tangle. For this reason, it is important to make sure wire recordings are played back and wound on a transport that is known to be in good working order. Adhesives from splicing are not a concern, because the process for wire recordings involves tying a square knot.





FIGURES 1.12 & 1.13
Wire recording.
Credit: AVP.

Improper storage, care, and handling practices may result in the following tape and/or wire issues, impairing reproduction:

- Deposits of matter such as dirt, dust, hair, and even fingerprints that create separation between the tape or wire and the head.
- Edge damage and tape deformation caused by mishandling, degradation, poor storage, or a bad transport. Even when slight, this type of damage can cause variation in the tape's contact with the head, resulting in the creation of artifacts.
- Broken or poorly repaired splices on both tape and wire.
- Adhesive extruding from splices and adhering to adjacent layers of tape.
- Binder system failure, including sticky shed syndrome, causing poor cohesion and high friction during transport of tape.
- A broken cassette or reel.
- Tangled wire.
- Magnetic particles that were originally recorded to tape, but scratched off or otherwise removed .
- Magnetic particles that were originally recorded but were exposed to a magnetic force that changed their magnetic state on both tape and wire.

Reproduction methods

The reproduction method for magnetic tape and wire is electromagnetic, meaning that the tape or wire reproducer head in the playback machine converts the magnetic energy stored on the tape or wire to electrons or voltage which is ultimately converted back to light and sound. It is critical that there be good and precise contact between the tape/wire and the playback head in order for the magnetic energy to be properly read and converted to electrons. It is also critical that the magnetic particles containing the recorded information remain in place and do not have their magnetic state altered.

Best practices for storage and handling

TAPE

Environment

- Store at temperatures between 32 and 61 degrees Fahrenheit,[4] with a relative humidity (RH) between 30%-50%. Temperatures should not fluctuate more than ±3 degrees within a 24-hour period. RH should not fluctuate more than ±5% within a 24-hour period.[5]
- Keep away from magnets, items containing magnets, and items generating magnetic force.

Housing

- Store on edge standing vertically.
- Containers should support reels by the hub.
- Place in housings that protect from external elements.
- Open reel tape should be stored tails out.
- The end of an open reel tape should be taped down, either to itself or the reel flange, using "hold down" tape intended for this purpose.
- Use only splicing tape for splices; use only hold down tape to secure tape ends.
- Wind cassettes all the way to one end.
- Avoid excessive pressure (enough to press a reel flange or cassette housing against the tape) on any side of the container or housing.

Handling

- Wear non-abrasive, non-shedding gloves if touching areas of the tape containing recorded information.

WIRE

Environment

- Store at temperatures between 33 and 54 degrees Fahrenheit, with RH between 30%-50%. Temperatures should not fluctuate more than ±3 degrees within a 24-hour period. RH should not fluctuate more than ±5% within a 24-hour period.
- Keep away from magnets, items containing magnets, and items generating magnetic force.

Housing

- Place in housings that protect from external elements.

Handling

- Do not touch areas of the wire containing recorded information without using non-abrasive, non-shedding gloves.
- Tie down end to keep it from coming loose and unwinding.
- Use only a square knot for splices.

FIGURES 1.14 & 1.15

Store magnetic tape on edge, standing vertically.

Credit: AVP.

4 Acetate-based magnetic tapes benefit from temperatures at the lower end of this range, polyester from the higher end.

5 ISO 18934:2011 *http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=55518*

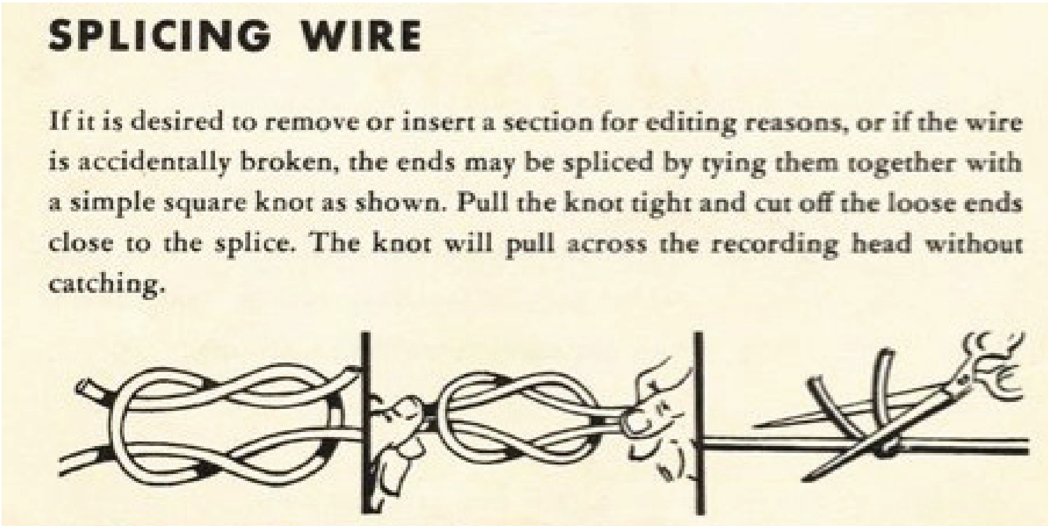


FIGURE 1.16

A splice in a magnetic wire recording.

Credit: Webster-Chicago Electronic Memory Portable Wire Recorder brochure, held by the Museum of Magnetic Sound Recording, Austin, TX.

SECTION 4: FILM

History

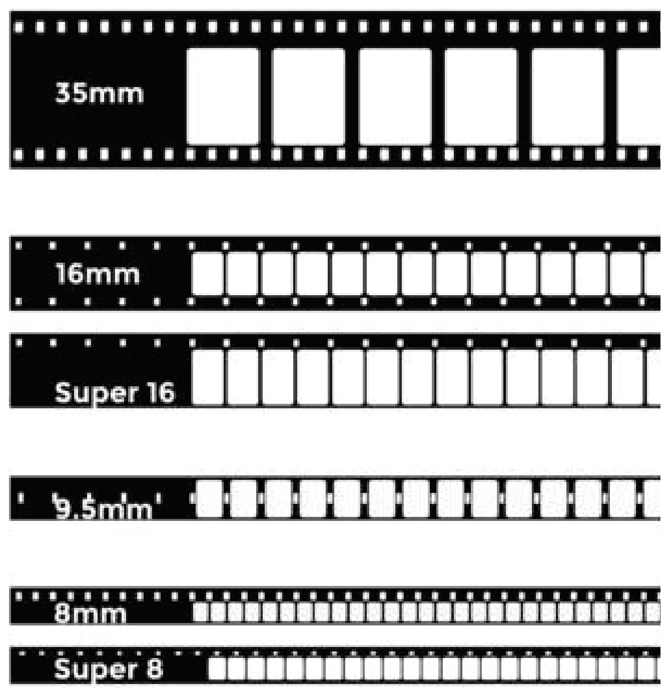
Film has a long history dating from the 1890s, lasting through to today. Due to technological limits, films began in the 1890s at less than a minute long and remained silent until 1927. The first commercially exhibited film in the United States was 35mm, which remains the industry standard today. Smaller gauges, such as 16mm and 8mm, are less expensive to use and are more popular in the amateur market. 16mm was introduced in 1923 by Kodak and is the most common gauge present in today's libraries and archives. 8mm was introduced by Kodak in 1932 and marketed to amateur film enthusiasts. Other gauges, such as 28mm and 9.5mm, are much rarer but may be present in your collections.

Film can be broken down into three main types consisting of image, optical sound, and magnetic sound. Each of these types has multiple sub-types and variants. While it is true for all media types, film more than any other demands an understanding of production and post-production processes and workflows in order to properly interpret what a given piece of film media is and how it should be considered, prioritized, and treated. A deep dive into the particulars of film production and post-production workflows and the corresponding media outputs is beyond the scope of this chapter, although the reader is strongly advised to review "Section 8: Additional Resources," which covers these topics.

FIGURE 1.17

Film gauge comparison chart.

Credit: Ryan Edge (CC BY-SA).



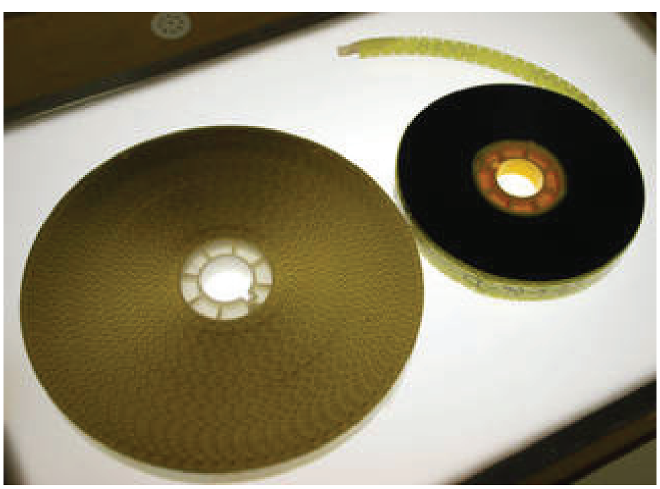
Materials and preservation risks

The three most common bases for film consist of nitrate, acetate, and polyester. Contrary to audiotape, polyester film is translucent when held up to the light and acetate is opaque.

The earliest of the three film bases in production was nitrate; notorious for its combustible properties, it became well known for the cause of major fires in projection booths, storage spaces, and archives. When nitrate is subjected to high heat and humidity, it can combust. Nitrate may be identified through edge printing or edge code if the manufacturer took advantage of this convention. Readers should note that it is also possible for the edge printing on nitrate film to be transferred to other film stocks in the film-to-film reformatting process. If nitrate is identified, it should be moved to a cold storage environment and prioritized for preservation reformatting. Decay in nitrate film is identified through discoloration, stickiness, odor, self-adhesion, deformation, and ultimately disintegration.

In 1909, acetate film[6] followed nitrate film, introduced as "safety film" due to its noncombustible properties. While safer than nitrate, acetate eventually demonstrated its own significant degradation mechanisms, the most common of which is known as "vinegar syndrome" due to the resulting odor. Promoted by storage conditions, the vinegar smell is a result of acetic acid production from a catalytic degradation process that is logarithmic in nature. At a certain point of degradation, the speed of decline is greatly increased, progressing from brittleness and a vinegar odor to delamination and decomposition. An early form of acetate known as diacetate can give off an odor of camphor or moth balls as it degrades. This process is known as "napthalene syndrome."[7] While not as widely used as acetate, diacetate film may exist in archival collections.

FIGURE 1.18
Polyester film (left) vs. acetate film (right).
Credit: https://psap.library.illinois.edu/collection-id-guide



Polyester was the latest film base to be introduced in the 1950s and has not yet exhibited significant degradation mechanisms, though discoloration and fading may occur.

Film image and sound can be together on one film (composite) or separated onto multiple films (separations) depending on at what type of recording it is and at what point in production or post-production process it was created.

The aforementioned film deformation resulting from degradation will negatively impact the ability to reproduce film images and magnetic and optical sound alike. Discoloration and fading can be an issue with polyester and acetate film bases, impacting both film images and optical sound tracks.

Depending on the type of film recording and where in the production or post-production workflow the film was created, there may be significant splices. These may consist of either tape splices or cement splices. Poor quality splices or degraded splices can result in the failure to bind two pieces of film together or cause an artifact in the image or sound.

Film is often stored on film cores without a reel or flanges, just like an open reel audio pancake. (See the polyester reel pictured above.) As with pancakes, film on cores is prone to becoming loose and unspooling, resulting in a mess of film that is difficult to put back in order.

Improper storage, care, and handling practices may result in the following film issues, impairing reproduction:

- Scratches, resulting in loss of image content and artifacts in image and sound.

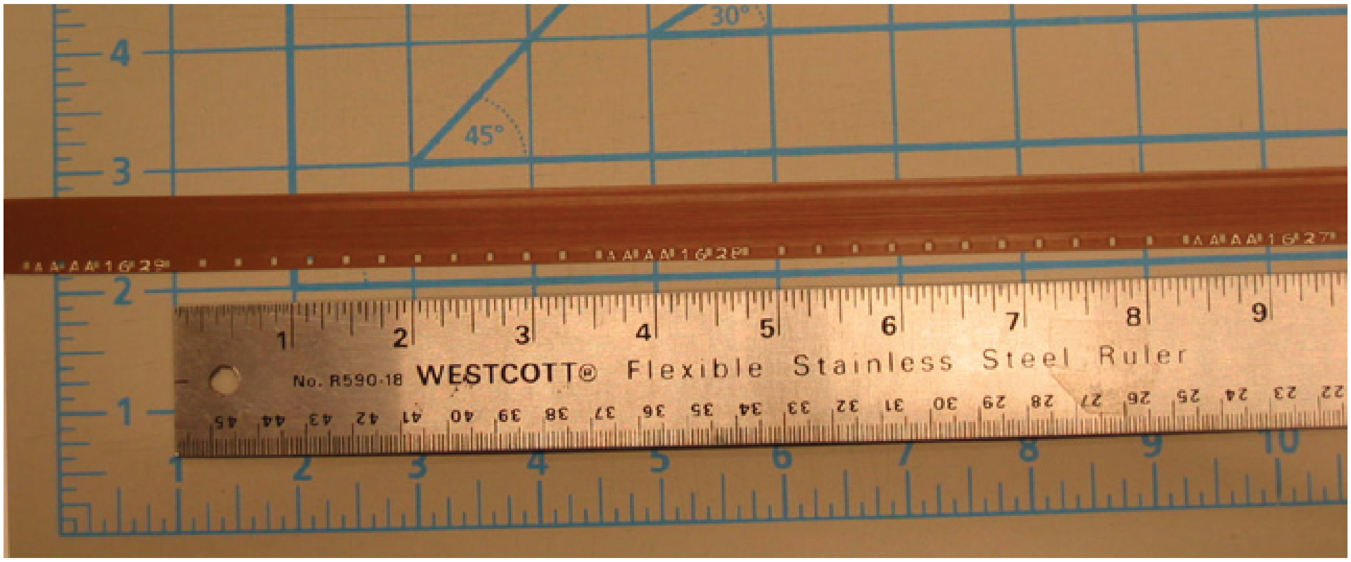
6 The term acetate is a collective name for Cellulose triacetate and Cellulose diacetate film. National Film and Sound Archive of Australia, "Acetate film," *https://www.nfsa.gov.au/preservation/preservation-glossary/acetate-film*

7 National Film and Sound Archive of Australia, "Napthalene Syndrome," *https://www.nfsa.gov.au/preservation/preservation-glossary/napthalene-syndrome*

FIGURE 1.19

A film with optical sound.

Credit: AVP.



- Fading or discoloration of the image or optical sound.
- Deformation of the film, causing distortion of the light as it passes through the film or poor contact between magnetic film and the magnetic head.
- Decomposition and delamination of the emulsion layer, resulting in loss.
- Matter such as dirt, dust, hair, and even fingerprints that create separation between the magnetic film and the head.
- Broken or poorly repaired splices.
- Film that is unwound from cores.
- Magnetic particles that were originally recorded but were exposed to a magnetic force that changed their magnetic state.

Reproduction methods

The reproduction method for film images, magnetic sound, and optical sound are all different. Like magnetic tape, magnetic film sound uses electromagnetic means of reproduction. Therefore, the same concerns exist regarding contact with the head and potential factors that may disrupt good contact.

There are two types of optical film sound, consisting of variable density and variable area. Both utilize an opto-electronic method of reproduction, shining light through the film into a light sensor on other side that converts light values to electrons.

Film images are reproduced through the projection of light through an image; the light that passes through the image may end up on a screen for viewing purposes. When digitizing, the light that passes through the film is read by photoelectric sensors that convert the light to electrons. Whether a film is a positive or a negative will impact the digitization process.

Best practices for storage and handling

Environment

- Film image and optical sound should be stored at temperatures between -4 and 46 degrees Fahrenheit, with RH between 30%-50%. Temperatures should not fluctuate more than ±3 degrees within a 24-hour period. RH should not fluctuate more than ±5% within a 24-hour period.
- Film magnetic sound should be stored at temperatures between 32 and 61 degrees Fahrenheit,[8] with RH between 30%-50%. Temperatures should not fluctuate more than ±3 degrees within a 24-hour period. RH should not fluctuate more than ±5% within a 24-hour period.

8 Acetate-based magnetic tapes benefit from temperatures at the lower end of this range, polyester from the higher end.

FIGURE 1.20

Store film on its side, lying horizontally.

Credit: AVP.

- Film images and optical sound should be kept out of light when not being used.
- Magnetic film sound should be kept away from magnets, items containing magnets, and items generating magnetic force.

Housing

- Film should be stored on its side so that it lays horizontally.
- The end of a film should be taped down, either to itself or the reel flange, using "hold down" tape intended for this purpose.
- Film should be in housing that protects it from external elements.

Handling

- Do not use any other type of tape or solution for splices other than film splicing tape and cement solution.
- Handle film by the edge. Do not touch areas of the film containing images or sound without using non-abrasive, non-shedding gloves.

SECTION 5: OPTICAL MEDIA

HISTORY

Audio compact discs (CDs) date from 1982 to the present. They represent the first successful consumer digital audio format. Composition varies between pressed CDs and DVDs (digital versatile discs) and those that are writeable and rewriteable (CD-R and CD-RW).

Pressed CDs are comprised of a protective lacquer layer, a metal data layer, and a polycarbonate plastic layer. Digital information is expressed in binary, and the metal data layer is molded to create pits; these pits reflect light differently than unaffected areas called lands. Playback is achieved through optoelectronic means: an optical stylus laser reads the pits and lands to reproduce the encoded information.

CD-Rs have a protective lacquer layer, an organic dye layer, a gold or silver metal reflective layer, and a polycarbonate plastic layer. The organic dye layer functions in much the same way as the metal data layer in a pressed CD; however, instead of being molded, the dye layer allows or blocks light transfer through the data layer, functioning in the same manner as the pits and lands.

CD-RWs have a protective lacquer layer, metal alloy recording layer, aluminum reflective layer, and a polycarbonate plastic layer. The metal alloy recording layer functions similarly to the dye layer in CD-Rs. The phase-changing metal alloy film can be altered in the same way the organic dyes can to reflect light.

DVDs were introduced to the market in 1995 and continue to be used today. They may contain any type of digital file, but commercially produced DVDs containing videos are common. Pressed DVDs are essentially two CDs glued together: a polycarbonate plastic layer, adhesive, a metal data layer, and a polycarbonate plastic layer. (The protective lacquer present on a CD is not needed on a DVD because the second polycarbonate layer acts as a protective layer.) DVDs can be two sided, meaning there may or may not be two recording layers present. Digital information is recorded in the same way as on a pressed CD: binary information is pressed into the metal data layer. Again, playback is through optoelectronic means using an optical stylus laser.

DVD-Rs have a polycarbonate plastic layer, an organic dye layer, a gold or silver metal reflective layer, and a polycarbonate plastic layer. The organic dye layer works the same as in a CD; the dye layer allows or blocks light transfer through the data layer. These, too, can be two-sided, with two dye layers and two metal reflective layers.

DVD-RWs have a polycarbonate plastic layer, metal alloy recording layer, aluminum reflective layer, and a polycarbonate plastic layer. The metal alloy recording layer functions the same as in CD-RWs; the phase-changing metal alloy film can be altered to reflect light. CD-RWs can be two-sided with two metal alloy recording layers and two reflective layers.

Materials and preservation risks

The polycarbonate layers in all optical disc types are easy to scratch or smudge, which may cause read errors or, if the damage is great enough, prevent successful playback. In addition, inks and adhesives used to label optical discs can harm the data stored in the top layer of the disc. The organic dyes used in optical discs will degrade over time, eventually making the disc unreadable. Delamination is possible through large swings in temperature and humidity; oxygen is introduced through the delamination process and can damage the data layer in CD- and DVD-RWs.

Improper storage, care, and handling practices may result in the following issues, impairing reproduction:

- Scratches or other means of damaging the data layer, therefore removing the data itself.
- Scratches on the polycarbonate layer, resulting in the inability of light to reach the data layer without distortion.
- Warping of the disc.
- Breakage of the disc.
- Discoloration of the layers resulting in the distortion of light values and the inability to retrieve the data.

Best practices for storage and handling

Environment

- Optical discs should be stored at temperatures between 41 and 68 degrees Fahrenheit, with a relative humidity (RH) between 30%-50%. Temperatures should not fluctuate more than ±2 degrees within a 24-hour period. RH should not fluctuate more than ±5% within a 24-hour period.
- Optical discs should be kept away from sources of heat, including sunlight or room lighting. Exposure to light greatly accelerates the fading of dyes.

Housing

- Optical discs should be stored on their edge so that they stand vertically.
- Optical discs should be in individual cases or Tyvek envelopes.
- Paper inserts should be removed and stored alongside the case or envelope. Paper can attract and hold moisture in humid environments.

Handling

- Handle the optical disc from the interior and exterior edges only. Do not touch the surface of the optical disc without using non-abrasive, non-shedding gloves. Fingerprints, smudges, scratches, particles of dirt or dust, solvents, or excessive moisture all may interfere with the ability of the laser to read the data layer.

FIGURE 1.21

Store optical discs on edge, standing vertically.

Credit: AVP.

SECTION 6: SHIPPING OF MEDIA CARRIERS

Sometimes collection materials must be moved in-house or to a third-party location. Even when transporting media carriers within the archive, careful handling is essential to protect the media from climatic changes, stray magnetic fields, and shock. Be sure items are secured on rolling carts and avoid bumps and uneven floors when moving collection items.

When shipping collection materials, ensure that the ambient temperature in the transport vehicle does not exceed 75 degrees Fahrenheit. Temperatures between 65 and 75 degrees F are acceptable, and this may require that materials are stored in containers that can maintain this temperature range while en route. In general, it is best to transport materials when outside temperatures are similar to materials' storage conditions, although this is not always possible. Avoid large swings in temperature and humidity.

Audio and Video Tapes

If you are going to ship audio and video cassettes and open reel tapes, be sure that each tape is supported by its container. Ship them the way you store them: on edge. It is most important to avoid shifting and shock. When packing smaller items within bigger boxes, be sure to surround them with enough packing materials so that they do not move or rub together during transport.

Discs

Discs of the same size can be stacked together horizontally in groups of five to ten. Separate each disc from its neighbors by placing each disc in a sleeve or by placing a smooth piece of paper between each pair of discs. Place each stack of five to ten discs between two rigid boards, creating a "sandwich." 1/2-inch honeycomb board or multiple layers of corrugated cardboard will work. Tape the edges together, taking care that no adhesive directly touches a disc. Wrap the entire sandwich in bubble wrap, and tape it closed. Place this package in a larger box and surround it with packing peanuts or bubble wrap. Multiple sandwiches may be placed in one larger box as long as there is room for padding between the sandwiches and the exterior box.

Cylinders

Cylinders may be shipped in their boxes. Wrap each box individually in bubble wrap, then place the wrapped boxes upright in a larger box. Make sure these boxes are tightly packed; if there is room for motion, fill in the spaces with bubble wrap or packing peanuts. Tape the box closed, then place the box in a larger box. Fill the spaces with packing peanuts or bubble wrap.

Film

Film can be damaged during transport if not packed correctly. It is important to protect film rolls against slipping. Check each film can for space and fill any existing space with bubble wrap or acid-free paper so it fits snugly. Place like-sized cans horizontally in a box, filling any gaps with bubble wrap or packing peanuts to ensure the films will not move during transport.

SECTION 7: CONCLUSION

Effective care of audiovisual materials requires an understanding of a format's history, physical components, reproduction methods, and best practices for storage and handling. Several different formats may be stored within a single repository, so this information can become overwhelming. One strategy is to use the information covered in this Chapter as a reference instead of attempting to memorize it all. Focus on learning the points relevant to the materials in your collection, and aim to improve your handling procedures and storage methods over time.

An important takeaway from this Chapter is that most formats cannot be treated in exactly the same way. Wax cylinders and vinyl discs need different types of storage containers to prevent physical damage, and film and videotape are reproduced through extremely different methods. Treating these materials with their differences in mind and referring back to this Chapter for specific information will greatly improve the stewardship of your collections.

It is also important to know exactly what you have in your collections so that you can improve their storage conditions and effectively select items for digitization. In "Chapter 2: Inventory and Assessment of Audiovisual Collections," you will learn how to develop an inventory of your collection that contains the data needed to care for and evaluate your collections for reformatting projects. You will be introduced to the required fields for inventory as well as additional fields that you may find helpful, and you will learn about the considerations that guide prioritization for digitization projects.

SECTION 8: ADDITIONAL RESOURCES

TABLE 1.1
Carrier Type, Media Type, and Reproduction Method Summary

Media Type	Format	Reproduction Method				
		Electro magnetic	Electro mechanical	Imaging	Opto electronic	Photo electronic
Magnetic Media	Tape	X				
	Wire	X				
Grooved Media	Disc		X	X		
	Cylinder		X	X		
Optical Media	CD				X	
	DVD				X	
Film Media	Image					X
	Optical Sound			X	X	
	Magnetic Sound	X				

TABLE 1.2
Storage Temperature and Humidity Summary

Storage Conditions		Magnetic Tape		Disc	Cylinder	CD, DVD	Film				
							Nitrate	Acetate		Polyester	
		Acetate	Polyester					B&W	Color	B&W	Color
Room	60°F-74°F 30%-50% RH	No	No	Fair	Fair	Fair	No	No	No	Fair	No
Cool	46°F-60°F 30%-50% RH	Fair	Good	Very Good	Very Good	Good	No	No	No	Good	No
Cold	32°F-46°F 30%-50% RH	Good	Fair	Good	Good	Good	Good	Good	Good	Very Good	Good
Subzero	-4°F-32°F 30%-50% RH	No	No	No	No	No	Very Good	Very Good	Very Good	Very Good	Very Good

Resources from the community

AUDIO RESOURCES

- NARA, How Do I Identify Audio Formats? *https://www.archives.gov/preservation/formats/audio-identify-formats.html*
- NARA, What are some important characteristics of audio formats? *https://www.archives.gov/preservation/formats/audio-important-characteristics.html*
- FACET: The Field Audio Collection Evaluation Tool, Format Characteristics and Preservation Problems Version 1.0 *http://www.dlib.indiana.edu/projects/sounddirections/facet/facet_formats.pdf*
- ARSC Guide for Audio Preservation, Chapter 2, Audio Formats: Characteristics and Deterioration *https://www.clir.org/pubs/reports/pub164/pub164.pdf*
- IASA TC-05, Chapter 2: Type of Carriers, Recording Principles, Composition, Physical and Chemical Stability, Deterioration by Replay *http://www.iasa-web.org/tc05/2-type-carriers-recording-principles-composition-physical-and-chemical-stability-deterioration*
- The History of Sound Recording Technology *https://recordinghistory.org*
- Chapter 3 (Disc Structure) of the CLIR report *Care and Handling of CDs and DVDs: A Guide for Librarians and Archivists* (PDF)
- An Introduction to Optical Media Preservation *http://www.avpreserve.com/wp-content/uploads/2014/04/OpticalMediaPreservation.pdf*
- IASA TC-05, Handling and Storage of Audio and Video Carriers, Chapter 2.3: Optical carriers *http://www.iasa-web.org/tc05/23-optical-carriers*
- ARSC Guide for Audio Preservation, Chapter 2.4 Optical Disc Formats *https://www.clir.org/pubs/reports/pub164/pub164.pdf*

VIDEO RESOURCES

- Mona Jimenez and Liss Platt, Videotape Identification and Assessment Guide. Texas Commission on the Arts, 2004 *http://www.arts.texas.gov/wp-content/uploads/2012/04/video.pdf*
- Timothy Vitale and Paul Messier, Video Preservation Website, Video Format Identification Guide on the Video Preservation Website, 2007 *http://videopreservation.conservation-us.org/vid_id/index.html*
- NARA, How Do I Identify Video Formats? *https://www.archives.gov/preservation/formats/video-identify-formats.html*

FILM RESOURCES

- NEDCC: A Short Guide to Film Base Photographic Materials *https://www.nedcc.org/free-resources/preservation-leaflets/5.-photographs/5.1-a-short-guide-to-film-base-photographic-materials-identification,-care,-and-duplication*
- IPI Storage Guide for Acetate Film *https://s3.cad.rit.edu/ipi-assets/publications/acetate_guide.pdf*
- Film Forever: The Home Film Preservation Guide *http://www.centerforhomemovies.org/filmforever*
- The Film Preservation Guide: The Basics for Libraries, Archives and Museums, National Film Preservation Board *http://www.filmpreservation.org/preservation-basics/the-film-preservation-guide-download*
- NARA, How Do I Identify Motion Picture Film Formats? *https://www.archives.gov/preservation/formats/motion-picture-film-identify-formats.html*
- The National Film and Sound Archive, Australia's website on Film Gauges *http://www.nfsa.gov.au/preservation/glossary/film-gauges*
- Richard Wright, DPC Technology Watch Report 12-01: Preserving Moving Pictures and Sound, 2012 *http://dx.doi.org/10.7207/twr12-01*

STORAGE AND SHIPPING REFERENCES

- Peter Z. Adelstein, IPI Media Storage Quick Reference, 2nd edition *https://s3.cad.rit.edu/ipi-assets/publications/msqr.pdf*
- Fred Byers, "Conditions that Affect CDs and DVDs" *https://www.clir.org/pubs/reports/pub121/sec5.html*
- IASA TC-05 Handling and Storage of Audio and Video Carriers, Chapter 3: Passive Preservation: Environmental Factors, Handling and Storage *http://www.iasa-web.org/tc05/3-passive-preservation-environmental-factors-handling-and-storage*
- NARA Directive 1571 Archival Storage Standards from the National Archives *https://www.archives.gov/foia/directives/nara1571.pdf*
- IASA TC-05 Handling and Storage of Audio and Video Carriers, Chapter 4.5.2: Storage Facilities and Transport *http://www.iasa-web.org/tc05/46-shelving*
- Film Forever: Chapter 8.2, Freezing your film, Five Easy Steps *http://www.filmforever.org*
- Film Preservation Guide, Chapter 5.8, Shipping your film *http://www.filmpreservation.org/userfiles/image/PDFs/fpg_5.pdf*
- SMPTE RP 103:1995 - SMPTE Recommended Practice —Care, Storage, Operation, Handling and Shipping of Magnetic Recording Tape for Television *http://ieeexplore.ieee.org/document/7291326/*

GLOSSARY

Active management: The performance of consistent and ongoing digital preservation activities (e.g. fixity and validation) to ensure a digital file's continued access for as long as necessary.

Artifact: Anomalies during visual or aural representations of recordings.

Audit trail: The information associated with a digital file that tracks the transactional history of it from the point of capture or ingest to know whether it has been managed without change to the bits that make it up and according to relevant policies and standards.

Authenticity: The quality of being genuine and free from tampering and is typically inferred from internal and external evidence, including its physical characteristics, structure, content, and context.[50] Trustworthiness.

Back coat: Layer added to some magnetic tape to help support the magnetic recording layer. The back coat reduces tape friction, dissipates static charge, and reduces tape distortion.

Binder system: System through which magnetic particles are held by a binder to a substrate layer.

Bit rot: The corruption, loss, or decay of bits, the building blocks of digital files.

Carrier type: Refers to the physical carrier of the AV material. Examples of carrier type include reels and cassettes.

Checksums: Alphanumeric strings that reflect the uniqueness of every digital file.

Curation: The activities that are performed on a digital file throughout its lifecycle, including selection and appraisal, description, ongoing care and management, long-term access, and/or deaccessioning/disposal.

Degradation: The process in which the quality or integrity of an object is destroyed over time.

Delamination: In disc media, the process that causes layers to separate from the support base.

Digital preservation: The active management of digital content over time to ensure ongoing access."[51] It is an integral part of curation (see definition above).

Digitization: The representation of an object, image, sound, moving image, or document by generating a series of numbers that describe a discrete set of its points.

File attendance: Ensuring that there are no missing or unexpectedly present files in a given location.

Fixity: File fixity refers to the property of a digital file being fixed, or unchanged. Fixity checking is the process of verifying that a digital object has not been altered or corrupted.[52]

Governance: In the informational sense, governance is the set of structures, policies, procedures, processes, and controls implemented to manage information at an enterprise level, supporting an organization's immediate and future regulatory, legal, risk, environmental and operational requirements.[53]

50 "Authenticity." Glossary of Archival and Records Terminology. Society of American Archivists. *http://www2.archivists.org/glossary/terms/a/authenticity*

51 "About." Digital Preservation. Library of Congress. *http://www.digitalpreservation.gov/about*

52 Wikipedia. File Fixity. *https://en.wikipedia.org/wiki/File_Fixity*. Accessed December 29, 2016.

53 Wikipedia. Information governance. *https://en.wikipedia.org/wiki/Information_governance*

Ingest: The process by which digital files and their associated metadata (called a Submission Information Package, or SIP) is deposited or submitted into a digital repository.

Latency: In computer networking, latency is the time interval between the request for information, such as a digital file, and the retrieval or display of that file to the user by the system.

Machine transport: Playback equipment.

Mandrel: A cylindrical rod placed through a cylinder and used to rotate it for playback.

Media type: AV materials are classified as audio, video, or film during the cataloging and inventory processes.

Metal evaporated tape process: Process in which magnetic particles are vaporized from a solid and deposited onto a substrate layer.

Migration: Converting from one format to another format considered to be of greater stability.

Obsolescence: The state of being which occurs when an object or practice is no longer wanted or used. Usually occurs when a new technology supersedes the old.

Preservation planning: A process by which the general and specific needs for the care of collections are determined, priorities are established, and resources for implementation are identified.

Refreshing: Copying information content from one storage media to the same storage media.[54]

Reproduction method: Method in which a recorded signal is played back from a physical media object.

Risk management: The systematic control of losses or damages, including the analysis of threats, implementation of measures to minimize such risks, and implementing recovery programs.[55]

RPM: Rotations per minute. Used to indicate recording speed for discs and cylinders.

Sidecar file: A file that is stored next to the AV file in the same directory.

Signal path: The route that an audio signal travels from source to output. This may be within a single device (CD to speaker within a stereo system) or within a workflow (original audio recording to reformatted digital file).

Slipping: Tape pack problem in which either single strands or groups of strands are misaligned and migrate to rest against the edge of the flange. May cause edge damage to the tape or film.

Splice: When two ends of a tape or film are joined together using specially formulated splicing tape.

Sticky shed syndrome: A condition resulting from the deterioration of the binder in magnetic tape that results in gummy residues on tape heads during playback.[56]

Storage architecture: The computing and network infrastructure required to store digital files.

Storage capacity: The amount of data a storage device can hold, often measured in gigabytes (GB), terabytes (TB), and petabytes (PB).

Storage media: Devices on which data is stored. These include computer hard disks, optical disk drives, USB drives and other external hard drives, DVDs, and magnetic data storage tapes.

Stylus: A hard point following a groove in a phonograph record and transmitting the recorded sound for reproduction.

Substrate: The backing film needed to support the magnetic recording layer of a magnetic tape.

Tails out: A method for winding tape onto a reel where the end of the tape is on the outside.

54 Digital Preservation Coalition Digital Preservation Handbook Glossary https://dpconline.org/handbook/glossary#R

55 "Risk Management." Glossary of Archival and Records Terminology. Society of American Archivists. *https://www2.archivists.org/glossary/terms/r/risk-management*

56 "Sticky Shed Syndrome." Glossary of Archival and Records Terminology. Society of American Archivists. *https://www2.archivists.org/glossary/terms/s/sticky-shed-syndrome*

NEDCC

NORTHEAST DOCUMENT CONSERVATION CENTER