NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

Conserve O Gram

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Preservation Of Magnetic Media

Park staff often find themselves accumulating libraries of audio and video tapes, computer back-up tapes, and floppy disks. Parks may have tapes of oral history interviews, of sounds of animals or old machinery, or of catalog records. Clearly, it is important to preserve this type of information for the future. However, unlike the print media, the magnetic media are *machine-readable data carriers*: to access the information one must use a machine, and perhaps use computer software. As a consequence, to preserve the information it is not enough to preserve only the media, i.e. the disks and tapes alone. It also is important to preserve, and keep operational, the machines that read the data. For example, a collection of wire recordings, an early magnetic medium, is useless without a working playback machine. For computer data, software also must be preserved.

Recommendations for the preservation of magnetic media must address not only the need for museum-quality environmental storage conditions, but must also address broader questions of how to make quality recordings, and how to control the conditions under which the media are used.

Properties of Magnetic Media

All magnetic media have a similar structure: a *base* or *substrate* layer, and a thin *binder* layer. Floating in the binder layer are the magnetic particles whose configuration determines the information content.

The base layer provides structural support for the thin and more fragile binder. From about 1935 until well into the 1960s, tapes were made from heavily plasticized cellulose acetate. In the early 1960s, a type of polyester material called polyethylene terephthalate began to be used. The most widely used polyester in tapes is the Mylar® brand, made by DuPont.

Acetate tapes have a tendency to become brittle due to loss of plasticizer and thus easily break. Polyester is much more stable, and degrades at a much slower rate than the binder it carries. The better grades of polyester tape that have been *tensilized* also have a much greater tensile strength than acetate tape, but can permanently stretch out of shape, whereas the more brittle acetate tape breaks cleanly.

The base layer for computer floppy disks is also a polyester, similar to that used for tapes, except that it is much thicker. The base layer for most computer hard disks, whether fixed or removable, is one or more aluminum or glass platters.

The binder layer, though thin, is a complex mixture of plastic resin, magnetic particles, solvents, wetting agents, plasticizers, antioxidants, lubricants, mineral powders, fungicides, and, sometimes, conductive particles. The art and technology of this mixture is the subject of much research by the manufacturers and results in formulations that are closely held trade secrets.

The many ingredients determine such properties of the layer as its flexibility, uniformity of composition, friction against the heads, abrasion resistance, static charge dissipation, adhesion to the substrate, and mold resistance.

Today, the most common resin used to make up the bulk of the binder layer is polyester

polyurethane. The most common magnetic particle dispersed in the binder is gamma ferric oxide (Fe_3O_2). Many cassette tapes use chromium dioxide (CrO_2) instead. For the more than a dozen different video formats, there are four broad classes: metal particle; oxide; cobalt doped; and metal evaporated.

Degradation Processes

The longevity of magnetic media is most seriously affected by processes that attack the binder resin. Moisture from the air is absorbed by the binder and reacts with the resin. The result is a gummy residue that can deposit on tape heads and cause tape layers to stick together. Reaction with moisture also can result in breaks in the long molecular chains of the binder. This weakens the physical properties of the binder and can result in a lack of adhesion to the backing. These reactions are greatly accelerated by the presence of acids. Typical sources would be the usual pollutant gases in the air, such as sulphur dioxide (SO_2) and nitrous oxides (NO_x), which react with moist air to form acids. Though acid inhibitors are usually built into the binder layer, over time they can lose their effectiveness.

Tapes are also subject to mechanical stresses. When played or rewound, the tape transport mechanism puts the tape under more or less tension. The tape then stretches somewhat to relieve the stress. This is called *cold flow.* Cold flow can result in a loosely packed reel, or even voids or buckling in the normally tightly packed reel.

The binder layer on tapes is also vulnerable to abrasion and scratching, such as result from contact with heads and guide rollers. Even a minute amount of dust can act as an abrasive, and can affect the ability of equipment to correctly read the magnetic signal.

Preservation Practices

The basic requirements for the storage and handling of magnetic media are as follows:

1. Keep them free of any foreign matter deposits.
2. Keep them free of any pressure that might cause deformation.
3. Store them in a stable, controlled environment.

Actions to Minimize Foreign Matter

- Enclose media in a sleeve or box. Use only *archival* quality materials such as acid-free paper, paperboard, paperboard-plastic laminate, or inert plastics such as polyethylene, polyester, or polycarbonate. The enclosure must be static-free.

- Do not leave items out in the air unnecessarily. Return them to their containers immediately after use. Do not leave storage containers open.

- Do not touch the playing surface. Use white lintless cotton gloves to handle tapes.

- Keep rooms where magnetic media are stored, and surfaces such as tabletops where they are handled, scrupulously clean. Vacuum often. Do not allow food, drinks, or smoking in the area. Avoid using sticky substances such as wax or dusting sprays that can contaminate machines as well as the playing surface. Paper should not be stored inside boxes of reel-to-reel tapes.

- Use filters on the air conditioning equipment and ensure that filters are periodically replaced.

- Clean equipment such as tape decks or disk drives regularly, following the manufacturer's instructions provided with each piece of equipment. When duplicating important tapes, for best sound quality, play only on a recently cleaned machine. When duplicating deteriorated tapes, clean the machine after *each* tape has played. This ensures that

debris will not carry over to the next tape and possibly damage it, and reduces possibility of damage to the heads.

- Remove the first 1½ winds of tape from a new reel of tape so that the adhesive from the end tab does not contaminate the tape, the reel, or the machine.

Actions to Reduce Deformation

- Store disks, cassettes, and boxes of tape reels vertically, not at a slant or horizontally. Provide vertical supports every 4 to 6 inches. Supports should not be smaller than the media container, i.e., supports in shelving for tape reel boxes should be no smaller in area than a box of tape.

- Do not pack storage units too tightly. Shelve with enough density to allow items to remain vertical, but not so dense as to result in excess sideways pressure.

- Store ten-inch reels of tape in boxes with supports for the hubs so the reel does not stand on its edge.

- Do not place heavy objects on floppy disks, tape reels, or cassettes.

- Store each size medium separately, so each can be fully supported and smaller items not become lost.

- Take care not to bend floppy disks.

- Keep away from heat and light, especially ultraviolet radiation (UV). Warm plastic can easily deform, and light can accelerate degradation processes.

- Take care not to drop magnetic media, especially heavy reels of tape. The shock of impact can derange some of the magnetic particles and result in a loss of information, such as high frequencies on audio tape.

- Keep all magnetic media at least 3" away from magnetic fields, such as 12-volt transformers, electric motors, older telephone ringers. Anti-theft detectors in libraries and stores can also be a problem. X-rays themselves are not a problem, but strong fields may be present near poorly shielded portions of the equipment.

- Store tapes in an *as played* condition, sometimes known as *tails out*, or an *archival wind*. The tape is thus stored with the lower tension of playback and not the higher and probably uneven tensions of rewind. Tapes should be rewound just before playing.

- To be able to store tapes at playback tension without the friction of passing across the tape heads, have a machine modified to guide the tape around the heads. Add tape guides and have the tension adjusted.

- Ensure that the tape winds evenly, i.e., the layers stack on each other and do not offset. Uneven winds can result in tape edge damage.

- Some authorities recommend periodic rewinding at intervals of 3½ years,[1] while others believe that this causes the retensioning process to start again and could lead to the eventual unreadability of the tape. They recommend that tapes be rewound only just before use and not periodically.[2] Extreme cases of bad packing or buckling, though, should be rewound when discovered.

Actions to Provide a Proper Environment

- Keep relative humidity and temperature levels constant. Fluctuations can be damaging. Avoid abrupt changes in temperature. Relative humidity should not vary more than ±3% in a month.

- Choose a set point for relative humidity levels in the range of 25% to 45%. A set point of 40% may be the most practical compromise

between effective dryness and the cost of attaining a more desirable RH.

- Set the temperature for dedicated storage in the range of 9°C to 15°C (49°F to 59°F) with 12°C (54°F) as the set point.

- Acclimatize materials stored at cooler temperatures for 24 hours before use in warmer work areas.

- Keep storerooms well ventilated so that pockets of stagnant air do not develop.

Other Considerations

- Always have *copies* available for everyday use. Keep the masters in storage.

- The archival storage copy of audio material should be on 1.5 mil mylar tape only. The thin tape in cassettes is not considered to be archival and is more subject to *print-through,* where information can transfer to adjacent layers, giving an echo effect.

- Use *mastering* grade tape for original recordings and archival copies.

- Have the bias and equalization of the tape machine adjusted by a professional to match the tape used.

- Copy important archival computer data to new disks or tapes every 5 to 7 years. This practice will ensure that the medium is always fresh, while the digital format ensures accurate information transfer. If it looks like the program that can read the data is about to become obsolete, make sure to convert the data into a form that can be read by current programs. Otherwise, the perfectly preserved tapes or disks may be inaccessible.

Notes

1. Gilles St-Laurent, *The Care and Handling of Recorded Sound Materials* (Washington, D.C.: Commission on Preservation and Access, 1991).

2. Leslie E. Smith, "Factors Governing the Long-term Stability of Polyester-based Recording Media," *Restaurator* Vol. 12 No. 4 (1991): 201-218.

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Dan Riss
Conservator
Division of Conservation
Harpers Ferry Center
National Park Service
Harpers Ferry, West Virginia 25425

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