



Conserve O Gram

September 1996

Number 19/19

Care Of Archival Compact Discs

Compact Discs (CD) have many advantages. Researchers search speedily through large quantities of documents on CDs, while protecting the original materials from excessive handling. An inexpensive distribution tool, CDs hold large quantities of data in a small space. During playing, no contact occurs between the playback device and the sound carrier so wear is minimized. Many CDs incorporate an *Error Detection And Correction* (EDAC) system that allows reconstruction of digital data when small errors or losses occur, making perfect copying possible. Since CDs vary little over time (until they fail), they may be duplicated without generational loss of information.

CD Life Expectancies

CDs are complex laminate structures vulnerable to damage by light, humidity, temperature, mishandling, and pressure. Since CD information is stored in blocks of data with EDAC correcting codes it isn't easy to determine when a CD is about to fail. CDs can be destroyed in a few minutes through poor handling or damaged from a few hours of being stored outside of their jewel cases.

Storage or handling that would not destroy tape or paper, such as bending, pressure, or light exposure, can destroy a CD. Don't count on CDs to last many decades because the polycarbonate substrate used on most CDs has a shorter life than paper or film. Few companies warranty their discs for more than a decade. Don't expect CD playback equipment for today's CDs to be available in 20 years, so equipment (and where appropriate, software) maintenance is essential. Don't dispose of your paper or film originals when using CDs for access copies.

Why CDs Fail

Most CDs fail because of:

- Physical stress leading to delamination, warping, and/or improper tracking
- Dirt or grit scratching media and leading to losses of information
- Yellowing of the plastic or light recording layer
- Low reflectivity due to oxidation of the aluminum layer (also known as *laser rot*)
- Natural aging

Standard CD Construction

Many CDs include a lacquer for durability, a reflective layer (usually aluminum; sometimes more stable gold), dyes (most frequently organic), and a substrate (often polycarbonate plastic, sometimes metal or etched glass) onto which the signals are etched by laser light. A marking agent, such as ink or an ink printed label, may be placed on the CD. Many of these materials, particularly the substrate, vary over time and by manufacturer.

Types of CDs

There are many CD technologies. The following are some of the most common types:

- *Write-Once, Read-Many Times* (WORM) format CDs are standard CDs commercially produced that may contain text, images, video, software, or sound.
- *Compact-Disc-Digital Audio* (CD-DA) is almost identical to standard WORM format CDs. CD-DAs are produced commercially for the popular music market.

- *Recordable Compact Discs (CD-R)* are WORM format CDs that are produced one-by-one non-commercially by a recording disc drive. CD-Rs are playable on standard CD-DA or CD-ROM players.
- *Rewritable CDs* can be erased and used again like magnetic media. Available in 90mm and 130mm digital optical formats, rewritable CDs require special players. Rewritable CDs use two separate technologies:
 1. *Magnetic-Optical Rewritable CD-MO* uses heat and magnetic fields to write the CD. Non-standard CD-MO players use polarized laser beams that indicate the magnetic orientation of each spot.
 2. *Phase Change CDs* use laser heat to change the media recording area from metallic to crystalline, thus changing the reflectivity of the recorded section

Evaluation of CD Materials

Look for CDs with a scratch resistant lacquer for durability, a gold reflector layer, thalocyanine dyes, and a stable glass substrate. For these discs, manufacturers quote life expectancies equivalent to paper and microfilm records; however, testing data is incomplete. Don't use CDs made with cyanine dyes because they are less light stable. CDs with aluminum reflection layers are more vulnerable to destruction due to oxidation (caused by excessive humidity coupled with airborne contaminants).

Most Durable CDs

According to conservators, such as William Nugent (see *References*), the following are the most durable CDs:

- Super CD
- Kodak Writable CD
- Kodak Photo CD
- Digipress Century Disc Gold
- Digipress Century-Disc Ark
- Digipress Century-Disc Eon

Where to Find Guidance

Don't get your preservation data from vendors. In the past vendors have often not disclosed when their products were non-archival or short-lived. Watch for media production, storage, housing, and player standards from the American National Standards Institute (ANSI) and the Association for Information and Imaging Management (AIIM) and recommendations and manuals from non-profit professional associations, such as the American Institute of Conservators (AIC) or the Society of American Archivists (SAA).

The chart on pages 3 and 4 provides guidance for preservation of archival CDs.

Sources

3M Software Media and CD-ROM Services
Bldg. 544-2N-01, 1185 Wolters Blvd.
Vadnais Heights, MN 55110
(612) 733-1110

Digipress SA
18 Rue Bailey
14050 CAEN Cedex, France
Fax (43) 31-47-25-02

Writable and Photo CD, Eastman Kodak
460 Buffalo Road
Rochester, NY 14652-3834
(800) 235-6325

CD Computer Aided Test System
CDCATS 5A3
Advanced Audio Development USA, Inc.
5335 Merle Hay Road, Suite 9
Johnstown, IA 50131
(515) 254-9494

Compact Disc Inspection System
Automatic Inspection Devices, Inc.
P.O. Box 6295
Toledo, OH 43614
(419) 536-2793

<p>To Preserve Your Archival CDs Do This...</p>	<p>Don't Do This...</p>
<p>Environment</p> <ul style="list-style-type: none"> • Store and use CDs at 10-20°C (50-68°F) and 40-50% RH, away from sudden changes in temperature and relative humidity. Poor temperature and humidity in CD storage and usage spaces may lead to warpage of the substrate and a resulting lack of CD flatness. CDs that aren't flat won't track, making them unplayable. • Store CDs in dark storage. Ultraviolet light, including sunlight, can cause the polycarbonate substrate or the scratch-resistant layer to darken, leading to player misreading and mistracking. • Store CDs in an air-conditioned space because polycarbonate substrates can absorb moisture and react to heat. These reactions in the substrate or the reflective layer can make the CDs unplayable. 	<ul style="list-style-type: none"> • Don't store CDs near heat sources, including the heat of ultraviolet light. Heat can cause the different layers of the CD to delaminate or can cause birefringence, the double bending of light. This optical effect leads to reduced signal strength and disc errors or failure. • Don't store CDs in high humidities because this may cause oxidation of the reflective layer.
<p>Housing CDs</p> <ul style="list-style-type: none"> • House CDs in jewel cases with an internal tray and hub to hold the CD in position. If software, the CD may be housed in paper sleeves. Polystyrene jewel cases are the preferred storage system, although paper or board housing that is certifiably acid-free is acceptable as long as it is boxed vertically in archival boxes. • Replace the jewel cases that have no internal tray or hub with ones that do. An ink-printed paper label may be fitted under the tray for reading through the jewel case cover. For long-term storage, remove any booklets, notes, or unadhered printed paper labels in the jewel case because they may be acidic. Key these items to the CD catalog number and house them in archival storage. 	<ul style="list-style-type: none"> • Don't use cracked or broken jewel cases; replace them with new ones. • Don't house CDs next to acidic paper, inks, or adhesives. • Don't mark CDs with adhesive labels, ink, graphite, or similar materials; instead, label their jewel cases. • Don't label CDs by writing directly upon either the CD or a pressure sensitive label that is already applied to the CD surface because this may lead to delamination. • Don't pull pressure sensitive tape or labels off CDs because this may lead to delamination.
<p>Storing CDs</p> <ul style="list-style-type: none"> • Select storage systems that protect CDs from excessive or cycling heat and cold, ultraviolet light exposure, air pollution, and scratching by dust or handling. • Store CDs and other optical discs vertically within their jewel cases in slotted racks or boxes, unless the CDs are played on a regular (daily) basis. CDs being played regularly should be housed in CD caddies. Caddies are polystyrene or acrylonitrile-butadiene-styrene (ABS) protective holders that contain many CDs for juke boxes or player auto-changers. 	<ul style="list-style-type: none"> • Don't tuck CDs into long term storage permanently. Check CDs for delamination and information loss at yearly intervals. See <i>Sources</i> above. • Don't use CDs for long term storage without keeping at least two copies of any hardware or software necessary for access. • Don't allow CDs to lean within their storage systems; keep them upright.

To Preserve Your Archival CDs Do This...	Don't Do This...
<p>Handling and Use</p> <ul style="list-style-type: none"> • Wear clean, white cotton (lint-free) gloves when handling CDs. • Hold the CD by the edges. Never flex, bend, or place pressure on a CD because this may cause delamination. • Hand deliver original CDs rather than shipping them. • Write on CD labels before applying them. If the CD is already labeled, add additional labeling to the CD housing. • Avoid rough handling of CDs. CDs play from the center to the outer edge. When a tracking problem exists, such as a player skipping sections of a CD, it is usually due to warpage, scratches, or delamination from improper handling. 	<ul style="list-style-type: none"> • Don't use the only copy of a CD created for long-term data storage. • Don't mark, label, or emboss a CD. • Don't ship original or sole copy CDs. • Don't use UPS, the mail, or public carriers to transport sole copy CDs. • Don't expose recordable CDs to light because it may lead to information loss. • Don't press down upon or scratch CDs.
<p>Cleaning CDs</p> <ul style="list-style-type: none"> • Clean CDs only when absolutely necessary. • Use compressed air for cleaning. • If compressed air doesn't work, dampen a cloth with distilled water and brush the CD to the outer edge from the center of the disc. Never use solvents. 	<ul style="list-style-type: none"> • Don't rub CDs because you may embed dirt in them. • Don't brush CDs in a circular movement because it may cause data error.
<p>Reformatting CDs</p> <ul style="list-style-type: none"> • Develop a reformatting schedule for migrating or remastering CD data. • Test CDs regularly so you know when to implement the plan. • Ensure that the contractor uses an EDAC technology system when copying CDs. EDAC incorporates mathematical formulas that ensure redundancy so that small sections of digital data can be reconstructed if lost or damaged. EDAC systems require almost 25% additional storage space on your new copy CD. Copying CDs is a slow and expensive job. • Set up an inspection process for CDs remastered or recopied prior to payment for the work. 	<ul style="list-style-type: none"> • Don't assume that you can tell when a CD is failing by looking at it; instead, test it to see how close the CD is to exceeding its EDAC limits. See <i>Sources</i> above. • Don't use CDs for long-term storage of data without setting up a data migration and remastering schedule. • Don't assume that reformatting CDs will be cheap. • Don't assume that you don't need to inspect copied CDs for completeness and accuracy.

References

- Bikson, T.K. and E.J. Frinkling. *Preserving the Present: Toward Viable Electronic Records*. The Netherlands: Sdu Publishers, The Hague, 1993.
- Fontaine, J.M. "The Preservation of Compact Discs, Principles of Analysis," *Archiving the Audio-Visual Heritage* by G. Boston, ed. Northants, UK: Technical Coordinating Committee and UNESCO, 1992.
- Nugent, William R. "Compact Discs and other Digital Optical Discs," *Storage of Natural History Collections: A Preventive Conservation Approach*. York, PA.: Society for the Preservation of Natural History Collections, 1995.
- Diane Vogt-O'Connor
Senior Archivist
Museum Management Program
National Park Service
Washington, DC 20013-7127

The *Conserve O Gram* series is published as a reference on collections management and curatorial issues. Mention of a product, a manufacturer, or a supplier by name in this publication does not constitute an endorsement of that product or supplier by the National Park Service. Sources named are not all inclusive. It is suggested that readers also seek alternative product and vendor information in order to assess the full range of available supplies and equipment.

The series is distributed to all NPS units and is available to non-NPS institutions and interested individuals by subscription through the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; FAX 202/512-2250. For further information and guidance concerning any of the topics or procedures addressed in the series, contact the NPS Museum Management Program, P.O. Box 37127, Washington, DC 20013-7127; 202/343-8142.