

Guidelines for Handling Fragile Materials for Purposes of Data Recovery

1.0 Introduction and Scope

The Data-PASS Partnership anticipates acquiring data in various forms, conditions and on a variety of media. The following outlines a series of guidelines or ‘best practices’ by which to approach the handling of specific older and potentially more fragile materials. It is not intended to provide strict guidelines on handling of all project acquisitions but focuses specifically on those that might be at the greatest risk due to the age and condition of the data source.

The basic approach taken by the partnership is to preserve the data and appropriate documentation and not the media onto which it has been written. In this way we attempt to avoid what Chen refers to as the “paradox of digital preservation: On the one hand, we want to maintain digital information intact as it was created; on the other we want to access this information dynamically and with the most advanced tools.”¹ Therefore, these guidelines are intended to provide assistance for short term handling of materials in preparation for migration to new media for processing.

Preserving the data successfully could still require much effort depending on a number of factors: 1) the physical condition of the media, 2) the potential obsolescence of the technology used to write/read the materials, 3) the viability of the media and 4) the availability of metadata regarding file formats and relationships among files.

While every data acquisition instance may be unique in its circumstances, these guidelines attempt to provide broad operating procedures for handling certain types of fragile materials resulting in the best chance of data recovery. Section 2 provides general guidelines for handling any fragile media. Section 3 outlines the importance of developing a technical inventory for collections acquired on older or potentially fragile media. Section 4 covers physical inspection of collection materials. Section 5 and Section 6 conclude with a look at issues of backup copies and transport of materials.

2.0 General guidelines

Conservationists and preservation researchers have developed a number of suggestions and guidelines for advancing the preservation of paper documents, works of art, and magnetic media of various types (audio tapes, video tapes, optical disks, etc.). The following is a compilation of the general but most relevant of these.

- Don't handle materials more than necessary
- Don't eat, drink or smoke where collections are stored, used or displayed
- Store materials in dark, cool, relatively dry locations until ready for evaluation and transfer
- Don't carry more than you can safely manage to avoid accidents or strain on the materials (or yourself)
- Don't work in cramped spaces

For more detailed guidelines also see:

Care and Handling of Alternative Media -- UC-Davis Library,

[<http://www.lib.ucdavis.edu/dept/preservation/altmedia.php>]

The Association of Moving Image Archivists,

[<http://www.amianet.org/publication/resources/guidelines/videofacts/intro.html>]

Smithsonian Center for Materials Research and Education,

[http://www.si.edu/scmre/relect/paper_handling.htm]

Preserving Works on Paper: Manuscripts, Drawings, Prints, Posters, Maps, Documents – Library of Congress, [<http://www.loc.gov/preserv/care/paper.html>]

3.0 Inventory of materials

To facilitate informed evaluation and decision making regarding processing of an acquired collection, additional descriptive information ought to be collected and further developed. The partner archive should develop an exhaustive inventory of the materials which includes a full accounting of known information about the history of the particular collection materials.

Elements of the inventory may include media type, media format, data format, platform on which the object was created, storage environments, etc.

Four basic dimensions have been identified for consideration in the inventory process (Table 1): type of expected material, type of media, type of platform and type of formats. For this project, one other dimension concerning the storage environment from which the collection was obtained (if available) has been added. Regarding file formats it is important to also reference and consider issues of format characterizations² and format relationships³ to provide details beyond basic format types. This additional information would include format versions and subtypes.

Table 1. Inventory Dimensions⁴

Type of	Examples
Material	Text, spreadsheets, datasets, databases, maps, etc.
Media	Punch cards, magnetic tape (9-track/7-track), magnetic disk (floppy/hard drives), etc.
Platform and Version	Win9x, WinNT, Unix, DOS, Mac, etc.
File Formats (including Characterizations and Relationships)	Recognized standard formats (TIFF, GIF, etc.) Recognized proprietary formats (MS-Word, SPSS .sav, MS-Access, IBM multi-punched, etc.)
Storage Environment	Climate controlled, damp basement, attic, etc.

The initial inventory may require some best estimates of some elements based on known values of others. For example an unlabeled magnetic tape containing a study conducted in 1987 in most cases will be 9-track rather than 7-track.

Information recorded in the inventory becomes the foundation on which to determine the most promising course of action for data recovery. More details are added to the inventory after a thorough physical evaluation of the media as outlined in the following section.

For more information see:

UK Data Archive Preservation Policy, [<http://www.data-archive.ac.uk/news/publications/UKDAPreservationPolicy0905.pdf>]

4.0 Physical handling, inspection and evaluation

A thorough physical evaluation of collection materials should provide detailed information on the size, quantity, and some type of description of their current disposition including a listing of apparent deficiencies. Precise procedures for this inspection depend upon the type of media. A list of common media types relative to this Data-PASS project are found below.

4.1 Handling and Inspection of Magnetic Tapes

The following 7-Step physical inspection of magnetic tapes has been adapted from a submission SPECS BROS., LLC [<http://www.specsbros.com>] authored for the American National Standards Institute Subcommittee on Magnetic Tape.⁵ This simple inspection process should be performed before putting any older magnetic tape on a machine for playback. It can also be used to perform an initial evaluation of the overall condition of older tapes in an archive. If a magnetic tape fails at any of the seven steps, the tape is at risk and machine mounting and playback should not be attempted. The inspection steps should be performed in the order listed.

- 1. Check physical container for damage that compromises the structural integrity of the container itself.** Breakage is a strong indication of improper handling. If the container, reel or cassette is damaged, the tape inside is also likely to have suffered damage or contamination.
- 2. Check the interior of the container and the edges of the tape for patterned black, brown, or mustard colored contamination and for fuzzy or thread-like growths that indicate the presence of fungus.** Fungus can grow on tape after it has been exposed to high humidity. Tapes with fungus should be isolated and treated by professionals as soon as possible. *Tape with fungus can present a health hazard: if fungus is suspected do not continue inspection!*
- 3. Smell the tape as soon as it is removed from its container.** Hydrolytic breakdown of polyester binder creates esters that have distinctive odors but dissipate quickly. The most common odors can be characterized as "waxy," "dirty socks," or "astringent/pungent" depending on the binder. Some early tapes using an acetate base will also give off an odor of "vinegar" if the base is beginning to decay. Tapes with binder hydrolysis are in the process of self-destruction and can stick in the machine during playback, causing additional damage. Binder hydrolysis can be treated: acetate breakdown is permanent.
- 4. With light source above and slightly behind, tilt tape edge-on at approximately 45° away from the light source and inspect tape pack.** Check for spoking, popped

strands, stepped pack, edge damage, "shiners" and windows. These terms refer to *irregularities in the way the tape is wound* onto the hub and are indications of improper handling, storage or a badly set up machine. Spoking shows up as a pattern radiating out from the hub and is the result of improper tension. Popped strands and stepped pack refer to individual or groups of tape wraps that stick up from the edge of the pack. When you shine the light on the tape, "shiners" show up as thin strips of greater reflection resulting from the edge of the tape being torn or folded. Windows are gaps in the tape pack caused by the tape becoming loose on the hub and often indicate a place where the tape has folded back over on itself.

5. **Check the tape edge and the reel/cassette/cartridge for particulate contamination and for signs of staining that may indicate liquid contamination.** Any visible contamination is an indication of poor storage or handling. Particulate contamination can block the signal during playback and can scratch both the tape and the playback heads. Liquid contamination will accelerate tape decay and can often result in tape wraps sticking together.
6. **Check the tape edge for white powder or crystalline residue and check the interior of the container for black/brown flakes of oxide.** These symptoms, caused by a variety of conditions, indicate that the tape is beginning to break down.
7. **If the tape is reel to reel, allow a few outer wraps to hang loose and examine for physical distortion and binder/base adhesion failure.** Physical distortion caused by improper tension will often show up on a loose piece of tape as wavy or "scalloped" edges. Binder/base failure is identified by sections of the tape that appear a different color where the binder has come off. Note: If transparent or masking tape has been used to secure the tape end, binder loss in the isolated area under the adhesive is not an indication of binder/base failure.

For more detailed guidelines also see:

Care, Handling and Storage of Removable Media – National Archives of the United Kingdom, [http://www.nationalarchives.gov.uk/preservation/advice/pdf/media_care.pdf]
Video Tape Preservation Fact Sheets -- AMIA,
[<http://www.amianet.org/publication/resources/guidelines/videofacts/inspection.html>]

4.2 Handling and Inspection of Punched Cards

In the best case scenario punched cards will have been stored in cardboard boxes or file cabinets specifically designed to hold several thousand cards in an orderly and compact fashion. The specific storage climate (based on temperature and humidity) directly impacts the condition of the paper cards. To enhance the possibilities for successful processing of punch cards, the cards should be stored in a climate-controlled environment temporarily. Cards that are torn, bent or in very brittle condition may require re-punching or post-hoc re-keyed replacement of the electronic record.

For more detailed guidelines also see:

Preserving Works on Paper: Manuscripts, Drawings, Prints, Posters, Maps, Documents – Library of Congress, [<http://www.loc.gov/preserv/care/paper.html>]
Emergency Drying Procedures for Water Damaged Collections – Library of Congress, [<http://www.loc.gov/preserv/emerg/dry.html>]

Procedures for Salvage of Water Damaged Library Materials – Conservation OnLine, Stanford University, [<http://palimpsest.stanford.edu/bytopic/disasters/primer/waters.html>]
Emergency Salvage of Wet Books and Records – Northeast Document Conservation Center, [<http://www.nedcc.org/plam3/tleaf37.htm>]
Emergency Salvage of Moldy Books and Paper – Northeast Document Conservation Center, [<http://www.nedcc.org/plam3/tleaf39.htm>]

4.3 Handling and Inspection of Magnetic Disks (3-1/2”, 5-1/4”, 8”, hard drives)

Magnetic disks should be handled with care, avoiding any close proximity to magnet fields such as machines with electric motors or magnetic screwdrivers. Inspect both the outside media holder as well as the immediate casing of the disk for any abnormalities, cracks, etc. To minimize the risk of mishandling the media directly, media should be removed from any protective casing only for immediate use. Additionally, specifically regarding floppy disks of any size:

- Do not bend floppy disks, but do lay them flat without any irregularities.
- Check the floppy disks for mechanical soundness: the disk protector should not be crimped, bent or hindered in anyway from functioning appropriately once in the drive.
- Write-protect floppy disks to prevent modification or destruction of data during processing.

For more detailed guidelines also see:

Protecting and handling magnetic media – National Archives of Australia, [<http://www.aa.gov.au/recordkeeping/rkpubs/advice/advice5.html>]

Care, Handling and Storage of Removable Media – National Archives of the United Kingdom, [http://www.nationalarchives.gov.uk/preservation/advice/pdf/media_care.pdf]

Cylinder, Disc and Tape Care in a Nutshell – Library of Congress, [<http://www.loc.gov/preserv/care/record.html>]

4.4 Handling and Inspection of Optical Disks (CD-ROM, CD-RW, DVD-ROM, DVD-RW)

As with other media types mentioned above, two main threats to the preservation of the contents of optical disks are media degradation and technological obsolescence. While in the case of optical storage disks specifically, technical obsolescence is probably the greater threat at present, care must still be taken to handle the disks properly and avoid inadvertently damaging the disk and losing the contents. Basic guidelines for working with optical media follow beginning with the most common cause of optical disk issues: inadvertent flexing or bending.

- Do not flex or bend the disk by any means, such as attempting removal from a jewel case or sitting on it.
- Do not touch the data side of the disk (the side of the disk with no label).

- Store the disk in its case and place it vertically, like a book, on a shelf. Long-term storage particularly in a heated environment, can cause the disc to become permanently bowed
- Do not apply paper labels or write on any part of the disk, data side or label side.
- If dust or fingerprints get on to the disk, wipe with a dry cloth from the center of the disk to the edge. Anything on an optical disk surface that impedes the ability of the laser to focus on the data layer can result in missing data as the disk is being read.
- Do not place the disk in any place where it will be subjected to direct sunlight or high temperature

For more detailed guidelines also see:

Care, Handling and Storage of Removable Media – National Archives of the United Kingdom, [http://www.nationalarchives.gov.uk/preservation/advice/pdf/media_care.pdf]

Protecting and handling optical disks – National Archives of Australia, [<http://www.aa.gov.au/recordkeeping/rkpubs/advice/advice6.html>]

Care and Handling of CDs and DVDs—A Guide for Librarians and Archivists -- CLIR, [<http://www.itl.nist.gov/div895/carefordisc/CDandDVDCareandHandlingGuide.pdf>]

(Disk cleaning guidelines can be found in Chapter 6)

Cylinder, Disc and Tape Care in a Nutshell – Library of Congress, [<http://www.loc.gov/preserv/care/record.html>]

5.0 Backup

As a general principle, legacy media should be backed up to provide a working copy of any materials queued for archival processing. Unfortunately, just the very act of creating a backup copy could endanger the original version. Therefore, in extreme cases, a backup copy may not be feasible. In these cases, the risk of media failure must be weighed against the potential for a successful read operation based on what is known about the legacy materials and familiarity with the particular media.

Additionally, in the special case of deteriorated punched cards, the punch cards (or, most likely, a subset of damaged cards) may be scanned or photocopied to provide a backup of materials without risking further damage by processing the cards. These are mechanisms that could be employed in extreme cases and not necessarily mandated for every case.

Finally, in those extreme cases, it may be advisable to discuss the situation in further detail with the project operations committee and potentially go so far as to solicit the help of an outside commercial data recovery specialist.

6.0 Transport

Transporting fragile media and related materials of almost any type can expose the media to a variety of risks. Primary among these risks would involve the impact of mishandled containers, uncontrolled environmental conditions during shipping, and theft or loss of materials. While the initial acquisition of fragile materials by a partner archive from a data source is the responsibility

of the partner archive, all partners must work to minimize exposure to such risks by operating within the following guidelines for transportation arrangements.

1. The partner archive will carefully handle, prepare and ship materials to another partner archive or vendor.
2. Each shipment should include a printed inventory of materials specific to that shipment.
3. The terms of shipping and insurance must be specified by the partner archives, shipping agent and, if applicable, the vendor.
4. The destination partner archive (or vendor) must notify the source partner of receipt of each shipment.
5. Acquired materials should be securely stored at the destination partner archive or vendor in a climate-controlled media-storage environment.
6. Original materials will be returned to the source partner archive after conversion has been completed.

For more detailed guidelines also see:

Video Tape Preservation Fact Sheets, Transporting Tapes -- AMIA,

[\[http://www.amianet.org/publication/resources/guidelines/videofacts/transporting.html\]](http://www.amianet.org/publication/resources/guidelines/videofacts/transporting.html)

¹ Chen, Su-Shing. "The Paradox of Digital Preservation," Computer. March 2001.

² "Tutorial: Using JHOVE." JHOVE - JSTOR/Harvard Object Validation Environment. 05-06-2006 . JSTOR and Harvard University Library. 10 Jul 2006 <<http://hul.harvard.edu/jhove/using.html>>.

³ "Sustainability of Digital Formats--Planning for Library of Congress Collections: Formats, Evaluation Factors, and Relationships." Sustainability of Digital Formats. 06-Mar-2006. Library of Congress. 10 Jul 2006 <http://www.digitalpreservation.gov/formats/intro/format_eval_rel.shtml>.

⁴ Bennett, John C. "A Framework of Data Types and Formats, and Issues Affecting the Long Term Preservation of Digital Material," British Library Research and Innovation Report 50:JISC/NPO Studies on the Preservation of Electronic Materials, 1997. 10 Jul 2006 <<http://www.ukoln.ac.uk/services/papers/bl/jisc-npo50/bennet.html>>.

⁵ Specs Bros White Paper, "Basic Inspection Techniques to Sample the Condition of Magnetic Tape," 2002. Specs Bros, LLC. 10 Jul 2006 <<http://www.specsbros.com/whitepaper.html>>.