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**Digital Preservation
Guidance Note:**

3

Care, Handling and Storage of Removable media

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1 Introduction

This document is one of a series of guidance notes produced by The National Archives, giving general advice on issues relating to the preservation and management of electronic records. It is intended for use by anyone involved in the creation of electronic records that may need to be preserved over the long term, as well as by those responsible for preservation.

This guidance note provides advice on the care, handling and storage of removable storage media. Electronic storage media are susceptible to damage through mishandling or inappropriate storage conditions – a sound knowledge of the correct handling and storage conditions for each type of medium is essential.

2 Types of Storage Media

It is preferable to use media that are based on mature, well-established technologies, to mitigate against obsolescence. The effective life span of any electronic storage medium is determined both by its physical longevity and the currency of the technology required to access it. Media life spans that greatly exceed those of their supporting hardware are therefore redundant. In practice, a proven life span of 10 years is sufficient for archival purposes, provided that an appropriate periodic refreshment regime is in place. This will entail the refreshment of data to new copies of the same media format, or migration to new media formats. For advice on the selection of appropriate media for long-term preservation, see Guidance Note 2 in this series.

This section provides an overview of the main removable media types currently available:

2.1 Flexible Magnetic Disks

These comprise a flexible magnetic disk housed within a rigid or semi-rigid casing. The most common type was, until recently, the standard 3.5" floppy disk, although other formats such as the Iomega Zip disk and the Superdisk may also be encountered. Storage capacities range from 1.44 MB to 250 MB. All types of floppy disk (3.5, 5.25" and 8") are now obsolete and should not be used. Due to their vulnerability, susceptibility to accidental erasure, and short life span (often less than five years), flexible magnetic disks have never been suitable for long-term data storage, and data stored on these should be copied to more recent media immediately.

2.2 Magnetic Tape

This encompasses a range of media utilising a magnetic recording layer on a flexible substrate (typically polyethylene naphthalate). The various formats of magnetic tape currently in use are all housed within cartridges (which have one spool) or cassettes (which have two spools). One of the most common low capacity types is Digital Audio Tape (DAT). High capacity formats such as Digital Linear Tape (DLT), which stopped being developed in February 2007, and Linear Tape Open (LTO) are generally considered to be the most stable and long-lasting formats at present. If stored and

handled properly, these high capacity formats should have a life span in excess of 30 years. Many tape technologies support hardware compression to increase capacity. Storage capacities range from 200 MB to 800 GB (compressed), although tapes with a capacity of up to 3.2 TB are in development. Magnetic tapes on open spools are now obsolete and should be migrated to other media.

2.3 Optical Disks

The most common forms of optical disk are the Compact Disc and the Digital Versatile Disc. The Compact Disc is available in read-only (CD-ROM), recordable (CD-R), and rewritable (CD-RW) formats. Recordable CDs comprise a dye layer and a metallic reflective layer on a clear polycarbonate substrate. Different combinations of metals and dyes are available, giving rise to media of different colours, but recent research suggests that CD-Rs which use a gold reflective layer and phthalocyanine-based dyes (often referred to as “gold/gold” disks) have the greatest life span and are most suitable for archival purposes. Widely differing claims have been made for the life expectancy of CD-Rs: these are estimated from accelerated ageing tests, and should be regarded with caution. CD-Rs offer storage capacities of 650 MB to 700 MB. CD-RW is based upon a different recording process to CD-R, and is not recommended for archival storage.

Compact Disc is likely to continue as a viable storage medium in the short to medium term. Digital Versatile Disc is replacing Compact Disc in some applications due to its higher storage capacity.

The Digital Versatile Disc (DVD) is available in read-only (DVD-ROM), recordable (DVD-R and DVD+R), and a variety of competing rewriteable formats (DVD-RAM, DVD-RW, and DVD+RW). Other permutations include single and double-sided disks, and dual recording layers per side. Recordable formats use organic dyes similar to CD-R, although many of the chemical formulations are not public. Rewriteable formats use phase-change technology, with the exception of DVD-RAM, which uses a combination of phase-change and magneto-optical technologies. Storage capacities range from 4.7 GB to 9.4 GB. The archival qualities of DVDs are not as well understood as CDs, but the recommendations for CDs should be applied.

More recently, two competing high definition optical disk formats emerged: HD DVD and Blu-ray. Support for HD DVD is being discontinued, and Blu-ray is currently the only high definition format in widespread use. Three recordable formats are available with storage capacities of 25 GB or 50 GB: BD-R (write once), BD-R LTH (write once), and BD-RE (rewritable). Holographic storage is also finally emerging, with the first commercial disks, promising 300 GB capacities, due to appear in 2008. It is, as yet, too early to judge the archival qualities of these media.

2.4 Solid-State Media

Solid-state storage devices use flash memory. Examples include the CompactFlash, SmartMedia and PCMCIA cards used in laptops, digital cameras and other peripheral devices and USB memory sticks. Storage capacities offered are in the range 512 MB to 128 GB. A drawback with flash memory is that it degrades with repeated use. The archival properties of solid-state media are not well understood – they should therefore

not be used for long-term storage, and data should be migrated to other media at the earliest possible opportunity. Flash memory sticks and cards are considered to be stable, as they have no moving parts. The drives can become unstable however, due to fragmentation problems. Industry research is continuing, but at present there is a risk of data loss as flash memory has a limited number of read / write cycles before the media may deteriorate. There are also possible quality control issues with the huge increase in production of flash memory sticks at increasingly lower prices. Flash memory should be considered for transfer between devices and very temporary storage only.

3 Care and Handling

Media should always be stored in the correct cases. For example, the containers for many types of tape cartridge are designed to minimise the risk from magnetic fields, and should therefore be used. Archival quality cases (manufactured from an inert polyester, which does not “out gas” chemicals which could damage the media) are recommended where available. Rigid jewel cases should always be used for optical disks, as opposed to sleeves, to give greater physical protection.

Media should be stored in their containers when not in use, and should not be left in drives unnecessarily, as this can cause both heat and mechanical damage.

Media should not be allowed to come into contact with liquids, dust, or smoke, and should not be exposed to either extreme heat or direct sunlight.

All types of media should be stored vertically, in a storage area which conforms to BS 5454:2000, such as a locked, fire-resistant data safe.

It is important to regularly check all stored media (ideally on a six-monthly basis). Media should be visually checked for signs of damage, and a random sample checked for readability.

Magnetic media should be kept away from potential sources of magnetic fields, including electrical equipment.

Media should be allowed to acclimatise for at least 24 hours within the operational area before use, in order to allow the effects of temperature and relative humidity to stabilise.

Drives should be maintained and cleaned on a regular basis, in order to prevent damage to media.

In addition, the following media-specific guidelines should be followed:

3.1 Flexible Magnetic Disks

All flexible magnetic disks should be handled in accordance with BS 4783, Part 3: 1988. In particular, the following should be observed:

-  The disk caddy must never be opened, nor the disk surface touched.

-  Labels should only be applied within the approved label area.
-  For archival data, the write-protect switch should be set immediately after writing.

3.2 Magnetic Tape Cartridges

All magnetic tape cartridges should be handled in accordance with BS 4783, Part 4: 1988, BS 4783, Part 5: 1991, and BS 4783, Part 8: 1994. In particular, the following should be observed:

-  Magnetic tape cartridges must not be opened, nor the tape surface touched.
-  Labels should only be used within the manufacturer's designated area.
-  Prior to use, tapes should be subject to a full forward and rewind cycle to equalise tape tension and, after writing, the tape should be fully rewound. Tape cartridges should also be re-tensioned annually by performing a full forward and rewind cycle.
-  For archival data, the write-protect switch should be set immediately after writing.

3.3 Magnetic Tape Reels

All magnetic tape reels should be handled in accordance with BS 4783, Part 2: 1988. In particular, the following should be observed:

-  Reels should only be handled either within their cases, or by the hub: the tape surface must never be touched.
-  Labels should only be applied within the approved label area, normally affixed to the front flange of the reel.

3.4 Optical Disks

All optical disks should be handled in accordance with BS 4783, Part 6: 1993 and BS 4783, Part 7: 1993. In particular, the following should be observed:

-  Discs should only be handled by the extreme edges or the centre hole, and the recording surface must not be touched. The upper surface of optical discs is the data-carrying layer, and therefore the most susceptible to damage although scratches or marks may also damage the polycarbonate lower surface.
-  Adhesive labelling kits must never be used, since these can disturb the mass balance of the disk and damage the data layer.

-  Discs may be marked on the upper surface using a soft tipped pen with water-soluble, permanent ink.
-  If necessary, the polycarbonate lower surface of discs may be cleaned by gently wiping straight from the centre to the edge of the disk (not in a spiral), using a lint-free cloth moistened with an approved cleaning fluid.

3.5 Solid State Media

All solid-state storage media should be handled with due care. In particular, the following should be observed:

-  Media should only be held by the extreme edges: the gold contacts must not be touched.
-  Labels should only be applied within the approved label area.

4 Environmental Conditions

All materials should be stored in an environment that provides protection from direct sunlight and ultra-violet light, and is free from chemical or particulate atmospheric pollutants. The environment should not be subject to rapid fluctuations in either temperature or humidity.

Storage areas for magnetic media should not contain large electrical devices or other equipment that may produce magnetic fields. The ambient stray magnetic field intensity should not exceed 4000 Amperes/metre.

Recommended environmental conditions are provided for both short and long-term storage. It should be noted that for electronic media, 'long-term' may well be less than 5 years.

4.1 Short-Term Storage

Media	Temperature	Relative Humidity
Flexible Magnetic Disks	10-51.5°C	20-80%
Digital Audio Tape (DAT)	5-45°C	20-80%
Digital Linear Tape (DLT)	16-32°C	20-80%
Ultrium Linear Tape Open (LTO)	16-32°C	10-80%
Other Magnetic Tape Cartridges	10-45°C	20-80%
CD-ROM/R/RW	10-50°C	10-80%
DVD-ROM/R/+R/RAM/RW/+RW	10-50°C	10-80%
Solid State Media	10-50°C	20-80%
Mixed Collections	16-32°C	20-80%

4.2 Long-Term Storage

Media	Temperature	Relative Humidity
Flexible Magnetic Disks	18-22°C	35-45%
Digital Audio Tape (DAT)	5-32°C	20-60%
Digital Linear Tape (DLT)	18-26°C	40-60%
Ultrium Linear Tape Open (LTO)	16-32°C	20-80%
Other Magnetic Tape Cartridges	18-22°C	35-45%
CD-ROM/R/RW	18-22°C	35-45%
DVD-ROM/R/+R/RAM/RW/+RW	18-22°C	35-45%
Solid State Media	18-22°C	35-45%
Mixed Collections	18-22°C	35-45%

5 Bibliography

BS 4783, Storage, transportation and maintenance of media for use in data processing and information storage

Part 2: 1988, Recommendations for magnetic tape on open spools

Part 3: 1988, Recommendations for flexible disk cartridges

Part 4: 1988, Recommendations for magnetic tape cartridges and cassettes

Part 5: 1991, Recommendations for 12.7mm magnetic tape cartridges for data interchange, recording at 1491 data bytes per millimetre on 18 tracks

Part 6: 1993, Recommendations for optical disk cartridges

Part 7: 1993, Recommendations for optical data disks (CD-ROM)

Part 8: 1994, Recommendations for 4mm and 8mm helical scan tape cartridges

BS 5454:2000, Storage and exhibition of archival documents