



# Conservation & Preservation of Computer Storage media

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## About the guidelines

This document covers requirements and recommendations for quarantine, preservation, long- and short-term retention conditions of computer storage media that are acquired as part of ASC collections; or that have derived as the output of digitisation (e.g. reel-to-reel tape digitised and stored in a DVD).

Quarantine and condition checks are a crucial part of our preservation process, ensuring that newly acquired storage media do not introduce contaminants that could harm existing collections; and that computer storage is stored, handled, and transported in a way that minimises the risk of damage or data loss.

The guide covers five broad categories of storage media, which are typically found in ASC collections:

- Magnetic disks
- Floppy disks
- Optical media
- Cassettes and tapes
- Solid state media

For each category, the following information is provided:

- Common media types covered.
- Environmental conditions for long-term storage (e.g. in the stacks).
- Conservation guidelines for storage, handling, visual inspection, transportation, acclimatisation and labelling.
- Sources - mostly British Standards documents and other sources as indicated.



# Magnetic disks

## Media types

Internal and portable hard disk drives (HDD), Iomega zip disks, Disk pack, Storage module (SMD), Disk Cartridge (Front-loading and top-leading)

## Long-term environmental conditions

Annual average temperature (°C)	20
Minimum average temperature (°C)	18
Maximum average temperature (°C)	22
Relative Humidity (%)	35-45

## Conservation and preservation

**Storage** No rapid changes in temperature, humidity or both.  
 Dust- and moisture-free storage and operational areas, away from dust-producing peripherals and moisture-emitting equipment.  
 No exposure to direct sunlight, intense magnetic fields, wireless telecommunications devices and peripherals, electrical devices, permanent magnets and lightning conductors.  
 Avoid environments affected by prolonged vibration.  
 Avoid environments that produce acidic and oxidising gases.  
 Remove any visible signs of dust and debris from the disk outer surface, using a clean brush. Do not use any method that can produce static charge.  
 Store portable HDDs in ESD-protected (antistatic) bag with a desiccant silica gel packet, as soon as acquired. Do not remove original packaging (e.g. box, case) and connection cables if present.  
 Store internal HDDs in ESD-protected (antistatic) clamshell with a desiccant silica gel packet, as soon as acquired.  
 Store vertically. Do not stack. Do not stand disks on their sides.  
 Store any connections cables and power sources that come with external HDDs/SSDs together with the disk.  
 Store on shelves within metal, fire resistant cabinets without magnetic catches.

<b>Handling</b>	Avoid dropping, jarring and shaking. Place on an ESD-protected mat when unpacked for processing. Do not leave in drives or connected to machines unnecessarily, as this can cause both heat and mechanical damage.
<b>Visual inspection</b>	Inspect for evidence of corrosion, especially rusty connectors/ports and chassis. Inspect for traces of moisture. Inspect for visible signs of dust and other debris on the casing of the disk. Inspect for cracks and bended parts on the chassis of the disk. Slowly rotate the disk and listen out for any rattling parts that have come loose inside the chassis.
<b>Transportation</b>	Keep disks in ESD-protected containers as prepared for Storage. Place in a heat-resistant, water, shock, and dust-proof protective case with foam cushioning. Follow acclimatisation and handling guidelines when unpacking at destination.
<b>Acclimatisation in operational environment</b>	Ideally acclimatise for 24h before use. Minimum acclimatisation of 2h within protective housing, enclosure or <a href="#">ESD-protected bag</a> . Mandatory 24h acclimatisation for disks that have been stored in environmental conditions outside recommendation above, to avoid condensation forming on disk surfaces.
<b>Labelling</b>	Use standard Avery labels and write with pencil or ballpoint pen before application to the disk surface. Make sure that ventilation holes and openings are not covered by the label. Do not write directly on disks. Do not place labels on top of manufacturer labelling. Do not place labels on any exposed circuit parts and connectors/ports (commonly located on the side of the disk).

### References:

[1] British Standards. (1988). BS 4783-1:1988; Storage, transportation and maintenance of media for use in data processing and information storage - Recommendations for disk packs, storage modules and disk cartridges.  
 [2] Lassere, M. (2019). Guidelines for Storing and Handling Born-Digital Media. Software Preservation Network. Available from: [https://www.softwarepreservationnetwork.org/wp-content/uploads/2020/06/UA\\_Guidelines-for-Storing-and-Handling-Removable-Media.pdf](https://www.softwarepreservationnetwork.org/wp-content/uploads/2020/06/UA_Guidelines-for-Storing-and-Handling-Removable-Media.pdf)  
 [3] Krogh, P. (2015). Hard drive Handling. Data Storage Hardware, Best Practices. American Society of Media Photographers. Available from: <https://www.dpbestflow.org/data-storage-hardware/hard-drive-handling#hard>



## Floppy disks

### Media types

3.5" floppy disks, 5.25" floppy disks, 8" floppy disks

### Long-term environmental conditions

Annual average temperature (°C)	20
Minimum average temperature (°C)	18
Maximum average temperature (°C)	22
Relative Humidity (%)	35-45

### Conservation and preservation

<b>Storage</b>	<p>No rapid changes in temperature, humidity or both.</p> <p>Dust- and moisture-free storage and operational areas, away from dust-producing peripherals and moisture-emitting equipment.</p> <p>No exposure to direct sunlight, intense magnetic fields, wireless telecommunications devices and peripherals, electrical devices, permanent magnets and lightning conductors.</p> <p>Avoid environments affected by prolonged vibration.</p> <p>Avoid environments that produce acidic and oxidising gases.</p> <p>Remove any visible signs of dust and debris from the disk outer surface, using a clean brush. Do not use any method that can produce static charge.</p> <p>Store 5.25" and 8" disk in their protective sleeve, if available. Alternatively, store disk individually in acid-free envelopes. Place disks in ESD-protected bag with a desiccant silica gel packet, as soon as acquired.</p> <p>Store 3.5" disk in ESD-protected (antistatic) bag with a desiccant silica gel packet, as soon as acquired. Always store vertically, in an upright position.</p> <p>For storing multiple disks, place upright in a plastic or acid-free box with a desiccant silica gel packet; and enclose the box with ESD-protected bag or antistatic film.</p> <p>Store on shelves within metal, fire resistant cabinets without magnetic catches.</p>
<b>Handling</b>	<p>Do not touch any exposed recording surface or pull back the shutter of a 3.5" disk.</p> <p>Follow guidelines and restrictions for Storage when handling.</p> <p>Place on an ESD-protected mat when unpacked for processing. Keep in an upright position as much as possible.</p> <p>Return to envelope immediately after removal from the drive and return to its storage box/case.</p> <p>For 3.5" disks: slide the write-protect tab to the write-protect position so you can see a hole through the case.</p> <p>For 5.25" and 8" disks: remove any write-enable labels from the write-protect notch.</p> <p>Do not bend or fold.</p> <p>The drive should not be switched on/off with the floppy disk still in the drive.</p> <p>Follow Storage guidelines where suitable while handling.</p>
<b>Visual inspection</b>	<p>Inspect the jacket and any exposed recording surface for traces of mould.</p> <p>Inspect for traces of moisture.</p> <p>Inspect for visible signs of dust and other debris on the casing of the disk.</p> <p>Inspect for cracks or tears on the chassis of the disk.</p>
<b>Transportation</b>	<p>Keep disks in ESD-protected containers as prepared for Storage.</p> <p>Place in a heat-resistant, water, shock, and dust-proof protective case with foam cushioning.</p> <p>Follow acclimatisation and handling guidelines when unpacking at destination.</p>
<b>Acclimatisation in operational environment</b>	<p>Ideally acclimatise for 24h before use.</p> <p>Minimum acclimatisation of 6h within protective envelope, case or ESD-protected bag.</p> <p>Mandatory 24h acclimatisation for disks that have been stored in environmental conditions outside recommendation above, to avoid condensation forming on disk surfaces.</p>
<b>Labelling</b>	<p>Use standard Avery labels and write with permanent ink pen before application to the disk jacket.</p> <p>Do not write directly on disks.</p>



Do not use graphite pencil or water-soluble felt-tipped pens to write on labels.  
For 3.5" disks: labels should be placed on the designated area, and not obstruct the shutter, the slide switch or the high-density hole.  
For 5.25" and 8" disks: Labels must not obstruct the index sensing hole and adhesive side of the label must not touch exposed recording surfaces.  
Do not place labels on top of existing labelling.

**References:**

- [1] British Standards. (1988). BS 4783-1:1988; Storage, transportation and maintenance of media for use in data processing and information storage - Recommendations for disk packs, storage modules and disk cartridges.
- [2] Lassere, M. (2019). Guidelines for Storing and Handling Born-Digital Media. Software Preservation Network. Available from: [https://www.softwarepreservationnetwork.org/wp-content/uploads/2020/06/UA\\_Guidelines-for-Storing-and-Handling-Removable-Media.pdf](https://www.softwarepreservationnetwork.org/wp-content/uploads/2020/06/UA_Guidelines-for-Storing-and-Handling-Removable-Media.pdf)
- [5] Brown, A. (2008). Care, Handling and Storage of Removable media. Digital Preservation Guidance Note: 3, The National Archives. Available from: <https://cdn.nationalarchives.gov.uk/documents/information-management/removable-media-care.pdf>



## Optical media

### Media types

CD-ROM, CD-R, CD-RW, Audio CD, DVD-ROM, DVD-RAM, DVD-RW, Blue-ray Disc, MiniDisc

### Long-term environmental conditions

<b>Annual average temperature (°C)</b>	20
<b>Minimum average temperature (°C)</b>	18
<b>Maximum average temperature (°C)</b>	22
<b>Relative Humidity (%)</b>	35-45

### Conservation and preservation

<b>Storage</b>	<p>No rapid changes in temperature, humidity or both. Dust- and moisture-free storage and operational areas, away from dust-producing peripherals and moisture-emitting equipment. Store in dark environment. No exposure to direct sunlight, high heat and sources of ultraviolet light. Avoid environments that produce acidic and oxidising gases. Remove dirt, foreign material, fingerprints, smudges, and liquids by wiping with a clean cotton fabric in a straight line from the centre of the disc toward the edge.</p> <p>Use CD/DVD-cleaning detergent, isopropyl alcohol, or methanol to carefully remove stubborn dirt or material. Avoid original packaging for optical media, especially DVDs, which can be less than desirable as the hubs may be too large or require excessive pressure to be applied to remove the disc. Always store vertically, in an upright position. Store in inert plastic or steel containers with a non-damaging centre hub, if the disc is to be kept long-term. Store in archival quality sleeves in all other cases. Store on shelves within metal, fire resistant cabinets.</p>
<b>Handling</b>	<p>Handle discs only by the outer edge or the centre hole. Avoid dirt or other foreign matter from touching or sticking to disc, including fingerprints from touching the disc's surfaces. If caddies are used, repeated loading and extraction of disks should be avoided to minimize disc damage. Do not allow contact with liquids, dust or smoke. Remove from drives that have been switched off and should be removed from drives that are inactive for long periods. Follow Storage guidelines where suitable while handling.</p>
<b>Visual inspection</b>	<p>Inspect for surface scratches, gouges, smudges, dirt, and dust that can inhibit playback of the disc. If gouges or scratches are deep enough, they may cause permanent damage to the disc and should be reported. Inspect the container and the disc for mould. Mould on the container is a good indicator that the mould has travelled to or from the disc. Inspect for "disc rot" - oxidation of the aluminium recording surface. observable indications of disc rot are pin-sized holes in the reflective layer, most visible when viewed against a light source, a bronze discoloration of the disc, and crazing distortion in the reflective appearance. Crazing can be seen in snowflake- or fractal-like milky-white patterns on the disc.</p>



<b>Transportation</b>	Keep disks in protective containers as prepared for Storage. Maintain in cool, dry conditions and do not allow condensation to occur on the disc surface. Follow acclimatisation and handling guidelines when unpacking at destination.
<b>Acclimatisation in operational environment</b>	Ideally acclimatise for 24h before use. Minimum acclimatisation of 6h within protective envelope or case. Mandatory 24h acclimatisation for discs that have been stored in environmental conditions outside recommendation above, to avoid condensation forming on disk surfaces.
<b>Labelling</b>	Adhesive labelling kits must never be used, since these can disturb the mass balance of the disk and damage the data layer. If adhesive labels are present, do not try to peel off or reposition. Discs may be marked on the upper surface using a soft tipped pen with water-soluble, permanent ink.  Do not use pencil, pen, fine-tip marker or markers that contain solvents to write on the disc. Never write on the laser-reading side of optical discs. Labels can be safely applied to caddies, sleeves or containers used to store optical discs.

#### References:

- [1] British Standards. (1988). BS 4783-1:1988; Storage, transportation and maintenance of media for use in data processing and information storage - Recommendations for disk packs, storage modules and disk cartridges.
- [2] Lassere, M. (2019). Guidelines for Storing and Handling Born-Digital Media. Software Preservation Network. Available from: [https://www.softwarepreservationnetwork.org/wp-content/uploads/2020/06/UA\\_Guidelines-for-Storing-and-Handling-Removable-Media.pdf](https://www.softwarepreservationnetwork.org/wp-content/uploads/2020/06/UA_Guidelines-for-Storing-and-Handling-Removable-Media.pdf)
- [4] Preservation Self-Assessment Program (PSAP). (nd). Optical media. University of Illinois at Urbana-Champaign. Available from: <https://psap.library.illinois.edu/advanced-help/av-opticalmedia>
- [5] Brown, A. (2008). Care, Handling and Storage of Removable media. Digital Preservation Guidance Note: 3, The National Archives. Available from: <https://cdn.nationalarchives.gov.uk/documents/information-management/removable-media-care.pdf>



## Cassettes and tapes

### Media types

Compact cassettes, Magnetic tape cartridges, Commodore Datassette, Digital Audio Tape (DAT)

### Long-term environmental conditions

<b>Annual average temperature (°C)</b>	20
<b>Minimum average temperature (°C)</b>	18
<b>Maximum average temperature (°C)</b>	22
<b>Relative Humidity (%)</b>	35-45

### Conservation and preservation

<b>Storage</b>	<p>No rapid changes in temperature, humidity or both.</p> <p>Dust- and moisture-free storage and operational areas, away from dust-producing peripherals and moisture-emitting equipment.</p> <p>No exposure to direct sunlight, intense magnetic fields, wireless telecommunications devices and peripherals, electrical devices, permanent magnets and lightning conductors.</p> <p>Avoid environments that produce acidic and oxidising gases.</p> <p>Store in original cases, if available, and in an upright position along the long edge.</p> <p>Remove any visible signs of dust and debris from the outer surface and case, using a clean brush and lint-free cloth. Do not use any method that can produce static charge.</p> <p>Wherever possible, rewind to the beginning-of-tape (BOT) before storage.</p> <p>Remove any write-enable labels or plastic tabs on both sides of the tape to enable write protection.</p> <p>Store on shelves within metal, fire resistant cabinets without magnetic catches.</p> <p>For storing multiple disks, place upright in a plastic or acid-free box with a desiccant silica gel packet; and enclose the box with ESD-protected bag or antistatic film.</p>
<b>Handling</b>	<p>Cassettes/tapes should remain in their containers until actually placed in the drive unit.</p> <p>Do not touch the exposed tape.</p> <p>Do not dismantle.</p> <p>Do not try to wind a cassette/tape by hand or instruments (e.g. pens) other than playback equipment.</p> <p>Remove from drive units that have been switched off.</p> <p>Follow Storage guidelines where suitable while handling.</p> <p>After acclimatization and before use, all cassette/tapes should be subjected to a full length forward and rewind cycle to stabilize the tension within the wind and to relieve any stress remaining.</p>
<b>Visual inspection</b>	<p>Inspect the case and cassette/tape for evidence of dust, debris, mould and moisture.</p> <p>Inspect for cracks and chips on the cassette/tape.</p> <p>Inspect that any labels on the cassette/tape are firmly affixed.</p> <p>Inspect for defects in the exposed tape such as base film deformation, creases, cinching and edge damage.</p>
<b>Transportation</b>	<p>Keep disks in protective containers as prepared for Storage.</p> <p>Any outer packaging needs to have a clean interior and sufficient sealing to prevent the ingress of dust and water.</p> <p>Follow acclimatisation and handling guidelines when unpacking at destination.</p>



<b>Acclimatisation in operational environment</b>	Ideally acclimatise for 24h before use. Minimum acclimatisation of 6h within protective case. Mandatory 24h acclimatisation for discs that have been stored in environmental conditions outside recommendation above, to avoid condensation forming on disk surfaces.
<b>Labelling</b>	Use standard Avery labels and write with permanent ink pen before application to the cassette/tape. Do not write directly on cassette/tapes. Do not use graphite pencil or water-soluble felt-tipped pens to write on labels. Do not place labels on top of existing labelling.

**References:**

[1] British Standards. (1988). BS 4783-4:1988; Storage, transportation and maintenance of media for use in data processing and information storage - Recommendations for disk packs, storage modules and disk cartridges.

British Standards. (1991). BS 4783-5:1991; Storage, transportation and maintenance of media for use in data processing and information storage - Recommendations for 12.7 mm magnetic tape cartridges for data interchange, recording at 1491 data bytes per millimetre on 18 tracks.

British Standards. (1994). BS 4783-8:1994; Storage, transportation and maintenance of media for use in data processing and information storage - Recommendations for 4 mm and 8 mm helical scan tape cartridges.





## Solid-state media

### Media types

Internal and portable solid-state drives (SSD), USB memory sticks, Memory cards (SD, SDHC, SDXC, SDUC), CompactFlash, SmartMedia and PCMCIA cards

### Long-term environmental conditions

<b>Annual average temperature (°C)</b>	20
<b>Minimum average temperature (°C)</b>	18
<b>Maximum average temperature (°C)</b>	22
<b>Relative Humidity (%)</b>	35-45

### Conservation and preservation

<b>Storage</b>	<p>No rapid changes in temperature, humidity or both.</p> <p>Dust- and moisture-free storage and operational areas, away from dust-producing peripherals and moisture-emitting equipment.</p> <p>Store in dark environment. No exposure to direct sunlight, high heat and sources of ultraviolet light.</p> <p>Avoid environments that produce acidic and oxidising gases.</p> <p>Store in original cases, if available, and in an upright position along the long edge. If original cases are not available, store in ESD-protected (antistatic) bag with a desiccant silica gel packet, as soon as acquired.</p> <p>Remove any visible signs of dust and debris from the outer surface and case, using a clean brush and lint-free cloth.</p> <p>For storing multiple disks, place upright in a plastic or acid-free box with a desiccant silica gel packet; and enclose the box with ESD-protected bag or antistatic film.</p> <p>Store on shelves within metal, fire resistant cabinets without magnetic catches.</p>
<b>Handling</b>	<p>Avoid rough handling and dropping. Do not open or separate the chassis.</p> <p>Do not allow contact with liquids, dust or smoke.</p> <p>Do not dismantle.</p> <p>If necessary, use short bursts of compressed air to dislodge dust.</p> <p>Do not touch any exposed contacts.</p> <p>Follow Storage guidelines where suitable while handling.</p>
<b>Visual inspection</b>	<p>Inspect for evidence of oxidation, especially oxidised connectors/ports.</p> <p>Inspect for traces of moisture.</p> <p>Inspect for cracks and chips on the outer chassis.</p>
<b>Transportation</b>	<p>Keep disks in protective containers as prepared for Storage.</p> <p>Any outer packaging needs to have a clean interior and sufficient sealing to prevent the ingress of dust and water.</p> <p>Follow acclimatisation and handling guidelines when unpacking at destination.</p>
<b>Acclimatisation in operational environment</b>	<p>Ideally acclimatise for 24h before use.</p> <p>Minimum acclimatisation of 2h within protective case.</p>



	Mandatory 24h acclimatisation for discs that have been stored in environmental conditions outside recommendation above, to avoid condensation forming on disk surfaces.
<b>Labelling</b>	Use standard Avery labels and write with pencil or ballpoint pen before application to medium surface. Make sure that ventilation holes and openings on SSDs are not covered by the label. Do not write directly on media. Do not place labels on top of manufacturer labelling. Do not place labels on any exposed circuit parts and connectors/ports.

**References:**

- [2] Lassere, M. (2019). Guidelines for Storing and Handling Born-Digital Media. Software Preservation Network. Available from: [https://www.softwarepreservationnetwork.org/wp-content/uploads/2020/06/UA\\_Guidelines-for-Storing-and-Handling-Removable-Media.pdf](https://www.softwarepreservationnetwork.org/wp-content/uploads/2020/06/UA_Guidelines-for-Storing-and-Handling-Removable-Media.pdf)
- [5] Brown, A. (2008). Care, Handling and Storage of Removable media. Digital Preservation Guidance Note: 3, The National Archives. Available from: <https://cdn.nationalarchives.gov.uk/documents/information-management/removable-media-care.pdf>