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Imaging materials — Magnetic hard drives used for image storage — Care and handling

Matériaux d'imagerie — Disques durs magnétiques utilisés pour le stockage d'images — Soins et manipulation

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 42, *Photography*.

Introduction

Magnetic hard disk drives (HDD) are used widely for short and extended-term storage of data, including audio, still, and moving images. HDDs are popular because they are small, inexpensive, self-contained, and have very high storage capacities. The most common form of HDD comes in a semi-sealed metal housing that measures 25 mm × 100 mm × 130 mm. Each unit has a connector for power and a connector for receiving and transmitting data and commands. Each HDD of this form contains one to as many as five 89 mm diameter magnetic disks (sometimes called platters) coated on an aluminium substrate. The location of working HDDs can be internal or external to computer workstations, and can be connected singly or in groups.

There are three broad categories of HDDs.

a) Consumer. Consumer HDDs are the most common types of HDDs. They are low in cost and are made for consumer and office work.

b) Enterprise. Enterprise HHDs cost more, are subjected to additional testing at the factory, and are intended for higher performance and reliability, and more intensive usage. They are typically used as part of data centre storage systems. They usually run at a higher rotational speed.

c) Miniature. Miniature HDDs have disks with smaller diameters and are used in mobile computers, including laptop computers and mobile consumer electronic devices.

There are several operating modes for HDDs, and these are described in Clause 3. In general, the three most common modes of HDDs are

a) online,

b) online but inactive, and

c) off-line.

The main longevity issues for HDDs are failures due to natural disasters, manufacturing defects, faulty electronic components, or obsolescence of the software interface. Proper care and handling helps reduce the risk of failure from physical impact, environmental extremes, and contamination, but proper care and handling by itself will not prevent failure. Migration and the making of backup copies are also strategies to mitigate against failure. Many HDD users migrate their entire digital collections every five years. Medium- and long-term storage of data on HDDs is not endorsed. Medium- and long-term storage of data on HDDs requires frequent backup copying, system mirroring, or other procedure to mitigate the significant problems posed by the use of HDDs.

HDDs used for storage purposes should not be left inactive for several years as no experience documents the reliability of HDDs in an extended idle storage mode. Also, all electronic media, including HDDs, have the possibility of failure. Therefore, all data shall be duplicated.

This International Standard focuses on the care and handling of HDDs, as well as the preservation of data stored on HDDs. The physical media is only one component in the preservation of data on HDDs. Data preservation is dependent on a total system to ensure data integrity.

Imaging materials — Magnetic hard drives used for image storage — Care and handling

1 Scope

This International Standard concerns the storage, care, and handling of HDDs. It recommends handling procedures to maximise the effective life of the data written on magnetic HDDs. Faulty care and handling methods can cause damage to a disk and the contents written thereon. It also recommends storage practices to preserve both the hard disk media and the content encoded thereon.

The recommendations in this International Standard apply where the desired result is extended-term retention of the data encoded on the disk. The use of the phrase "care and handling" in this International Standard is restricted to the physical domain or hardware aspects of the HDD. This International Standard is not intended to address associated or relative system aspects of HDDs. With recognition that the scope of systems is covered in other standards, this International Standard precisely aims to fill a void of information on HDDs as physical media with failure mechanisms and handling risks.

This International Standard does not promote or advocate that proper physical care and handling represents the only element on the path to extended-term usage (more than two years), but rather is part of a comprehensive set of practices to mitigate risks in the long term preservation of content stored on HDDs.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
advanced technology attachment
ATA
type of protocol that interfaces the hard disk drive with the computer

Note 1 to entry: Also, see SATA.

2.2
backup
duplicate of stored data

Note 1 to entry: It is recommended to store the back-ups at a remote site in case of a disaster.

2.3
BLER
number of erroneous blocks per second measured at the input of the C1 decoder (see ISO/IEC 60908) during playback at the standard (x 1) data rate averaged over a 10 second measuring period

Note 1 to entry: Standards ISO/IEC 10149 and ANSI/NAPM IT9.21-1996 specify a maximum BLER rate of 220.

2.4
cartridge
housing for recording media

Note 1 to entry: Cartridges for removable HDDs contain only the disk and not the read/write heads or interface electronics.

2.5
disk array
multiple HDDs with a common controller and file system

2.6
disk format
structure and composition of data storage on a disk

2.7
enterprise storage
ES HDDs
HDDs intended for data center storage systems with higher performance and reliability, and usually running at higher rotational speed

Note 1 to entry: These cost more than consumer HDDs, but are subjected to additional testing at the factory.

2.8
extended-term storage conditions.
storage conditions suitable for the preservation of recorded information having permanent value

2.9
fibre channel
FC
hard drive electrical-optical interconnect allowing high performance data transfer speed

2.10
file
encapsulation of data and metadata

2.11
file format
structure and composition of data and its associated metadata in a file

2.12
hard disk
writable computer storage medium consisting of an aluminum alloy platter coated with a magnetic material and a protective layer

2.13
hard disk drive
HDD
electromechanical device consisting of one or more magnetic disks (platters), read & write heads, a motor, and control electronics usually contained within an enclosure and used to store data

Note 1 to entry: Also commonly referred to as hard drives or disk drives.

2.14
integrated development environment
IDE
software application that provides comprehensive facilities to computer programmers for software development

2.15
massive array of idle disks
MAID
disk array consisting of HDDs that are normally inactive but can be powered up quickly on demand

Note 1 to entry: These HDDs can be configured as a RAID system with the data written on more than one HDD.

2.16
media
any physical material that stores data

2.17
migration
copying of data from one storage medium to another

2.18
mirrored HDDs
data storage configuration in which identical data is stored on two or more HDDs

2.19
parallel advanced technology attachment
PATA
parallel HDD interconnect protocol

Note 1 to entry: See SATA.

2.20
parity
disk management configuration which stores error correction information (checksums) on a dedicated disk for the purpose of automatic data recovery

2.21
redundant array of independent disks
RAID
disk array that employs two or more drives in combination for fault tolerance and performance

Note 1 to entry: The HDDs are always spinning and data can be written over several HDDs. There are several RAID levels, with increasing performance per level (noted below). Levels 1 – 5 still maintain a risk of total data loss.

Note 2 to entry: See the Appendix for the description of each RAID level.

2.22
reformat
copying of data file or files from one file format to another file format

2.23
refresh
copying of data files without change in file format or medium

2.24
serial advanced technology attachment
SATA
HDD interconnect protocol that is faster than parallel (PATA)

Note 1 to entry: Also see ATA.

2.25
server
computer system that provides data and software to one or more computers on a network

2.26
small computer system interface
SCSI
HDD data transfer and control protocol that allows high speed data transfer between a computer/workstation and peripherals.

Note 1 to entry: SCSI is a common interface for enterprise HDDs.

2.27
smart monitoring and reporting technology
SMART
standard diagnostic protocol built into HDDs and used to monitor the operating condition of a HDD or HDDs and report potential problems to the user

2.28
striping
segmentation of logically sequential data, such as a single file, so that segments can be assigned to multiple HDDs

3 HDD components

HDDs are magnetic storage devices consisting of one or more disks requiring a connection to a compatible computer or other host device to allow for the persistent storage of data and/or programs. The following are the components of an HDD.

3.1 Disks

HDDs contain one or more disk per HDD, each disk having a magnetic coating. Each disk is made of aluminium with a thin coating of a magnetic material covered by a protective layer. The magnetic coating is sometimes coated with a lubricant.

3.2 Motor and spindle

The disks are mounted on a common spindle usually concentric to the centre shaft of the drive motor.

3.3 Read/Write head

An electromagnetic transducer mounted on the moving end of an arm that traverses the disk reading and writing data constitutes the typical read/write head. The head floats just above the disk surface on a very thin cushion of air.

3.4 Servo head

The servo head is a separate magnetic head that is mounted on a movable arm located at the base of a spindle. Pre-written tracks located on the disk are used to track rotation of the disk and to track read/write locations on the written disk.

3.5 Control electronics

Control electronics consist of circuitry and components that control the drive sub-systems, including the heads, the disks, and the motor to enable the reading and writing of magnetic signals containing digital data. Some HDD functions are controlled by these pre-programmed electronics and some are controlled by a separate drive controller.

3.6 Interconnections

HDDs are only useful when using one of several established interconnection protocols which include physical specifications as well as logical specifications for data transfer control functions. The physical specification defines the cables, shapes of connectors, and electrical parameters. The logical specification models the data structure and the command sets.

External connector protocols attach HDD’s to drive controllers and computers. Examples of internal protocols are IDE, PATA, and SATA. Examples of external protocols are the four-pin firewire (IEEE 1384) cable or the USB cable. SCSI is an example of an internal and external specification. For use of features like SMART and temperature monitoring, a 40-pin cable for information along with a four pin power cable is required. Some interconnection standards include power to the drive while others require a separate power supply. There are several standards in each category which are subject to change.

4 Possible physical configurations

4.1 Disk arrays

Several HDDs, in most of the cases mounted in 19-inch wide racks and controlled by a computer, are called disk arrays.

4.2 Single HDD

A single HDD can be read using a small desktop enclosure that is connected through cable to a computer.

5 Access and usage options

5.1 Online HDDs (connected and powered)

Disk arrays can be powered constantly, and can be instantly accessible. However, continually operating HDDs in this state will consume power and can wear out the moving elements sooner. Disks that are operated constantly are continuously accessible by the host system and can perform self-monitoring operations. RAID-5 is the most commonly used disk array configuration. RAID-5 has a potential problem because the data can be lost if a second error is detected during the time that the system is correcting an error. RAID-6 does not have this problem, but RAID-6 requires more memory than RAID-5. See Annex A.

To avoid data loss, RAID systems shall not be powered off during error-checking or rebuilding operations.

5.2 Online but inactive HDDs (connected, not spinning)

MAID disk arrays of HDDs will last longer because they are normally idle (powered off). Also, since they are normally idle, they use much less power than a RAID system.

5.3 Off-line (not connected, not spinning)

HDDs can be disconnected completely from host systems and can be placed on shelves in an archive the same way that tapes and films are stored. They shall be sample-tested once each year. HDDs stored on shelves have the potential danger of not being usable in the future if the system software is changed without checking that all of the different types of HDDs on the shelves are compatible with the new software. This will require the guidance of an experienced technician or information technologist.

These three usage options for HDDs are all capable of maintaining persistence of data but differ in accessibility.

Table 1 — Hard disk drive usage options

	Connected	Spinning
Online	Yes	Yes
Inactive	Yes	No
Offline	No	No

6 Reliability

To ensure the integrity of the data on an HDD, the drive shall be turned on and checked a minimum of once every two years.

Disk arrays can be configured so that each HDD is fully tested in automated mode for errors on a periodic basis. If an HDD has excessive errors, it can either be copied automatically or the computer can flag the problem for the operator to decide on the proper course of action.