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Document management — Monitoring and verification of information stored on 130 mm optical media

Gestion de documents — Surveillance et vérification de l'information stockée sur des supports optiques de 130 mm

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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Introduction

Many organizations now use optical media for long-term storage of information. It is assumed that a disk selected for recording has already been qualified for that purpose. It is therefore important to be able to verify that data have been recorded correctly and remain readable for the required amount of time. Previous ISO Standards clearly specified requirements for interchange, and methods for predicting the lifetime of optical media but did not contain methods for validation of the quality of written data.

Longevity is limited both by media degradation and by technology obsolescence. Interchange needs to be regularly verified to assure that information on existing recorded media will continue to be recoverable. Users can have a maintenance policy that protects disks against unanticipated failure or use, such as by making one archival copy, another to function as a backup or master, and another for routine access. Hardware support lifecycles typically vary between 5 years to 10 years and technology lifecycles usually end after 20 years. Consequently, recordings that require a longer lifecycle might have to be transferred to upgraded platforms every 10 years to 20 years.

Optical media for long-term storage should be evaluated. Significant longevity differences can exist for disks from different media manufacturers and also between disks from the same media manufacturer. Degradation can be more rapid for disks of very poor initial quality than for high quality recordings. Disks with an initially poor quality do not offer sufficient headroom to avoid reaching the unrecoverable error threshold before the next scheduled inspection, which for archival disks is to be avoided. This means that a disk of high initial recorded quality that maintains this condition for life is expected to have superior longevity.

Powerful cyclic redundancy check (CRC) error correction systems that are embedded in the disk and utilized by the drive can mask degradation. In the absence of drive standards, functionality does not allow the user to verify, in a simple manner, the quality of information recorded on a particular disk. Methods described in this International Standard specify a quality control policy that can non-destructively identify degradation, and thereby support timely and effective corrective action.

Document management — Monitoring and verification of information stored on 130 mm optical media

1 Scope

This International Standard specifies test methods to determine the quality of data on recorded media and provides specifications enabling end-user organizations to monitor data quality and ongoing conformance with the error limits required for its class identified by the manufacturer of the drive/media. This International Standard defines error rate monitoring capabilities and procedures associated with 130 mm optical media while being used in a production environment to ensure that data are still readable throughout the expected life of the media.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 12651, *Electronic imaging — Vocabulary*

ISO/IEC 17345, *Information technology — Data interchange on 130 mm rewritable and write once read many ultra density optical (UDO) disk cartridges — Capacity: 30 Gbytes per cartridge — First generation*

ISO/IEC 11976, *Data interchange on 130 mm rewritable and write-once-read-many ultra density optical (UDO) disk cartridges — Capacity: 60 Gbytes per cartridge — Second generation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12651, ISO/IEC 17345, ISO/IEC 11976, and the following apply.

3.1
end-of life
EOL
loss of interchange whereby information cannot be reliably retrieved

4 Test method

4.1 General

The method specified in this International Standard to determine the quality of data on recorded media is based on a knowledge of the error correcting codes used to correct for inevitable media defects and the deterioration during normal life of the media. At the time of writing, the data should be verified by the writing system. During this verification process, the level of defects shall be checked and only data which require a small percentage of the error correction capability shall be accepted by the writing system. This International Standard defines a method for subsequent analysis of the remaining error correction capability when the

media are read on a reference drive. In addition, the performance of the servos on the media shall be checked to determine if any unacceptable media distortion has occurred.

4.2 Calibration of test drive

The drive manufacturer provides reference disks, that have been checked on calibrated equipment. These media shall be provided with a test report documenting the acceptable range of results that shall be obtained when scanned on a drive to be used for archive data scanning. Any drive used to perform the media quality tests shall pass the check with reference media.

4.3 Test parameters

The remaining error correction capability and servo performance of the media that are scanned shall be measured using a media scan. In order to keep the scan to a manageable time, a percentage of the surface shall be scanned.

During the scan of a disk, the following operations shall be performed.

a) The surface of the media shall be scanned to determine the location of written sectors.

b) A minimum of every tenth track of user written data shall be read and the number of errors in each code word calculated so as to ensure that there is sufficient remaining correction capability in the written sectors. The user may select to scan 100 % of the data depending on the value attributed to the content of the media.

c) If $>$ 75 % of the available error correction capability in any sector tested is required to recover valid data, the media shall be reported as being at risk. In this case, the first measure shall be to clean the media according to the manufacturer's instructions and to rescan for defects. If the same error is reported, the data should be migrated within 2 years of the date of testing.

d) The servo channels shall be monitored to verify that none of the allowable thresholds are exceeded, for example due to surface dust or scratches. The maximum servo disturbances are defined in the relevant ISO specification for the media type (ISO/IEC 17345, ISO/IEC 11976). In this case, the first measure shall be to clean the media according to the manufacturer's instructions and to rescan for defects. If the same error is reported, the data should be migrated within two years of the date of testing.

e) The sector addresses shall be checked to ensure that at least one ID field in every sector is readable without errors. If this condition is not met, the media shall be reported as being at risk. In this case, the first measure shall be to clean the media according to the manufacturer's instructions and to rescan for defects. If the same error is reported, the data should be migrated within two years of the date of testing.

f) The remaining spares area shall be checked to ensure that the relocation rate is acceptable. Less than 50 % of the spares allowed shall have been used. The spares allowed shall be allocated in proportion to the percentage of the user area written. If this condition is not met, the media shall be reported as being at risk. In this case, the first measure shall be to clean the media according to the manufacturer's instructions and to rescan for defects. If the same error is reported, the data should be migrated within two years of the date of testing.

4.4 Test set-up

Before testing a media cartridge, the drive to be used shall be calibrated using reference media supplied by the drive manufacturer. The cartridge to be tested should be inspected for physical damage but no attempt should be made to clean the media surface.

In general, media cleaning is detrimental to performance unless carried out using the correct materials to a specification. Only in the event of a disk cartridge failing the scan, should the media be cleaned. See informative Annex A for recommendations on disk cleaning. Disk cleaning should only be performed using the recommended disk cleaner and cleaning fluid supplied by the media vendor.

On no account shall the user disassemble the disk cartridge.

4.5 Procedure

The tester shall use a software application, certified by the drive manufacturer to accurately identify media errors on certified media to verify certified media on a drive connected to a computer via a computer interface. The tester shall be able to enter a disk serial number and this shall be added to the test file generated by the test.

Before testing media, verify the system by checking the reference media supplied with the test drive. Insert the reference disk into the drive, and then execute the “system check” option. The drive shall read the calibration file from the reference disk and perform a media scan of the identified sectors. The results of this scan shall be compared with the calibration file to ensure that the drive correctly identifies defective sectors. At the end of the calibration check, the test results shall be written on the calibration disk for future analysis.

If the drive passes the calibration check, insert the disk to be checked into the test drive. The application shall read the unique media ID written at the time of manufacture and shall be able to display this to the operator. In the event that these media have previously been checked using the test application, the previous test file shall be retrieved and used to check the rate of deterioration of data quality.

When prompted, enter a text comment, which is appended to the test file. Execute the test application, scanning the media for written sectors. A percentage of these sectors as specified in 4.3 shall then be read and an analysis of the error correction status shall be made on a sector-by-sector basis as follows.

— The test application shall be used to analyse the user data and check the number of errors in each error correcting code word to ensure that there is sufficient residual error correction capability as specified in 4.3.

— The quality of the embossed address information shall be checked as specified in 4.3 to ensure reliable access without the implementation of recovery routines.

— The servo channels shall be monitored as specified in 4.3 to determine if the focus or tracking error exceeds the limits allowed in the media specification.

At the end of the test, a test file shall be written to a specified disk drive on the host PC. Based on the analysis of the defects found during the scan, the application shall report the status to the user.

4.6 Test result evaluation

As indicated in the preceding section, the test application shall automatically generate a test file and recommendations for action required. There are three possible results from tests executed as specified in 4.5 as follows.

a) Disk cleaning is recommended after which the disk shall be re-tested.

b) The data have reached end of life and should be copied to new media. This result is only reported if media have been retested after cleaning. This is determined by the existence of two successive file records for the media concerned where the media fail one of the following criteria:

   1) any code word has less than 25 % of its total error correction capability remaining;

   2) if any servo disturbances which exceed the limits allowed in the relevant media specification (ISO/IEC 17345, ISO/IEC 11976) are detected.

c) If neither of the conditions 1) and 2) are detected, the data shall be reported as in good condition and no action is necessary.

NOTE This evaluation defines the limits according to a published International Standard and repeats the conditions outlined in 4.3.

5 Error classification

There are two general types of deterioration that may cause errors in user data on optical media.

a) Optical media used for professional archiving use powerful error correction coding to ensure that inherent media defects can be corrected without errors. Thus any data errors at the media level are not seen at the user level. However, as defects grow either through surface contamination or gradual deterioration of the recording layers (see Annex B), with time the error correction codes are no longer able to reconstruct the source data without errors.

b) In addition, the mechanical integrity of the media may deteriorate to a level where the servo systems are no longer able to follow the data sufficiently accurately and large data drop-outs may occur.

This International Standard defines a media scan methodology that checks that neither of these deterioration mechanisms is approaching a level that might cause irretrievable loss of data at the user level.

The scan routines specified in this International Standard are designed to ensure that any additional defects occurring in normal usage are still well within the correction capability of a standard drive.

Media which successfully pass the data integrity check can be regarded as in good condition. This implies that the writing system used at the time of recording wrote good data and that little or no deterioration of the data has occurred.

6 Test frequency

6.1 General

The frequency of testing required to confirm the quality of data stored on optical media depends on the nature of the storage environment and the technology used. Media, which are stored within the media manufacturer's recommended storage conditions, should not require frequent checking.

In the case of media stored within the manufacturer's recommended environmental conditions, testing should be carried out every 5 years.

If the media are subjected to abnormal conditions as a result of a system failure, for example, the media manufacturer's advice should be sought.

6.2 130 mm optical media

130 mm optical media stored in an automated library should not require checking on a frequent basis. As a matter of good practice, it is recommended that sample disks should be scanned every three years to ensure that the system performance is not compromised.

Media used in stand-alone applications can be subject to less well-controlled storage conditions. The actual frequency should be determined by the user depending on the degree of control of the storage environment, but for critical applications sample disks should be scanned at least every 2 years.

7 Prevention of deterioration

130 mm optical media used for archiving shall be stored within the media manufacturer's recommended storage conditions. Care should be taken to avoid rapid changes of storage temperature and humidity and in particular, non-condensing conditions shall be maintained. By its nature, optical media can be affected by particulate contamination. Media used for professional applications are therefore usually retained within a sealed cartridge, which should not be opened in normal circumstances. Disks intended for long-term archiving should not be left in the drive.

NOTE See informative Annex B for a more detailed description of the causes of deterioration.

Annex A
(informative)

Recommendations on handling, storage and cleaning conditions for ultra density optical (UDO) media

A.1 Handling

UDO media is housed in a rigid protective cartridge. This cartridge is designed to protect the disk from both physical damage caused by accidental dropping or the ingress of contamination. Media should always be handled with care and opening of the media shutters should be avoided. Never touch the media surface. Avoid subjecting the media to unnecessary extremes of temperature.

A.2 Storage

For long-term dark storage the storage environment should be limited to the ranges given in Table A.1.

Table A.1 — Recommended long-term storage ranges

Ambient condition	Recommended long-term storage range
Temperature	−10 °C to 30 °C
Relative humidity	3 % to 80 %
Absolute humidity	1 g/m^3 to 30 g/m^3
Atmospheric pressure	60 kPa to 106 kPa
Temperature gradient	15 °C/h maximum
Relative humidity gradient	10 %/h maximum

No condensation on, or in, the optical disk cartridge should occur.

A.3 Cleaning

UDO media should only be cleaned using approved cleaning materials and tools recommended by the media manufacturer. Users should contact their local distributor or the media manufacturer.

Annex B
(informative)

Causes of deterioration for ultra density optical (UDO) media

B.1 Deterioration

The technology of UDO media has been exhaustively tested and there are no reasons to believe that the recording film deteriorates if the media manufacturer's recommendations for storage and use are adhered to. UDO media are housed in a protective cartridge with a two-piece shutter so only the surface being written or read is exposed to the external environment. This minimizes the entry of contamination during usage. In addition, the surface of UDO media is hard-coated in order to facilitate cleaning and to prevent scratching which can occur on polycarbonate substrates. However, despite the presence of a protective substrate and cartridge, all optical media are susceptible to surface contamination in use.

B.2 Disk structure

UDO media comprise two identical disks bonded back to back and as such, the symmetrical construction minimizes distortions associated with changes in ambient conditions. The adhesive selected for the bonding of the two disks is selected so as to minimize stresses from the bonding process.

The disk is protected by a rigid polycarbonate cartridge, which has been designed to survive a drop from 1,2 m onto any corner or surface.

B.3 Causes of deterioration

The most likely cause of deterioration is the arrival of surface contamination as indicated in B.1. This contamination can obscure the active layer and create dropouts in the data. Furthermore, particulate contamination may cause transients in the servo signals used by the drive to maintain focus and tracking to the required accuracy. One of the most frequent causes of uncontrolled contamination is the casual cleaning of media using unapproved materials and procedures. Because the media are housed in a protective cartridge, improper cleaning is not necessarily visible on a simple inspection. Cleaning of media should only be carried out in accordance with the procedures listed in Annex A.

As with all optical media, small defects are allowed at the time of manufacture. Over a long period of time under extreme environmental exposure these defects may grow. The growth of these defects can be shown to follow Arrhenius' laws and this method is used to confirm the predicted lifetime of UDO media. The residual error correction capability referred to in 4.5 is designed to ensure that data are still readable throughout the expected life of the media.

B.4 Nature of deterioration

The operating environment determines the nature of the deterioration. In the case of media used in a library, this environment is well controlled, however, operation of media in stand-alone drives potentially subjects the media to a wider range of contamination and environmental extremes. In particular, disks left in uncontrolled storage may be subject to physical abuse or contamination exacerbated by casual opening of the media shutters in contravention of media manufacturer's recommendations.

B.5 Effects of deterioration

The combination of beam obscuration and possible disturbance to the servo signals may result in a dropout in the data reaching the decoder. While the error correction code has a very high burst correction capability (greater than 1 mm), a large dust particle may cause this capability to be exceeded.

ICS 37.080

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