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Audio archive system – **STANDARD PREVIEW**
Part 1-1: DVD disk and data migration for long-term audio data storage
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IEC 62702-1-1:2016
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Système d'archivage audio –
Partie 1-1: Disque DVD et migration de données pour le stockage à long terme
des données audio





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INTERNATIONAL STANDARD

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Audio archive system –
Part 1-1: DVD disk and data migration for long-term audio data storage

Système d'archivage audio –
Partie 1-1: Disque DVD et migration de données pour le stockage à long terme
des données audio

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AUDIO ARCHIVE SYSTEM –

Part 1-1: DVD disk and data migration for long-term audio data storage

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The text of this standard is based on the following documents:

CDV	Report on voting
100/2449/CDV	100/2518/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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The contents of the corrigendum of February 2018 have been included in this copy.

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INTRODUCTION

Sound recordings such as music, speech, and storytelling are an important human heritage and should be preserved for as long as possible. However, we were not able to record sounds in order to preserve them in the past. The first recoding was achieved by Edison in 1877.

Although various technologies were invented later, most of them have limitations for audio archives because storage life time is limited and the sound quality deteriorates when it is transferred to the next generation storage device.

The progress of LSI technology made digital recording of recorded sound possible. The digital recording is very suitable for audio archiving because the migration is performed by copying digital data.

For this purpose various recording materials exist, such as optical disks, magnetic disks, magnetic tape and nonvolatile memory such as a phase change memory.

This International Standard specifies physical and logical aspects for a standard of audio archives of various storage types which are typically used for audio archives in markets.

The IEC 62702 series currently consists of:

Part 1 specifies the minimum requirements on physical aspects of optical disks for digital sound recordings. Part 1-1 specifies DVD optical disks, and Part 1-2 specifies BD optical disks.

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Part 2 specifies the minimum requirements for digitization of content, format of digitised content, content information and media inspection.

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AUDIO ARCHIVE SYSTEM –

Part 1-1: DVD disk and data migration for long-term audio data storage

1 Scope

This part of IEC 62702 specifies a method of data-quality assurance for writable DVD disks (hereinafter disks) which are specified for long-term data storage, and a data migration method which can sustain the recorded data on disks for long-term audio data preservation. The writable disks include recordable disks such as DVD-R, and +R format, and rewritable disks such as DVD-RW, +RW format and DVD-RAM.

2 Normative references

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

ISO/IEC 16448:2002, *Information technology – 120 mm DVD – Read-only disk*

ISO/IEC 16963, *Information technology – Digitally recorded media for information interchange and storage – Test method for the estimation of lifetime of optical media for long-term data storage*

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ISO/IEC 29121:2013, *Information technology – Digitally recorded media for information interchange and storage – Data migration method for DVD-R, DVD-RW, DVD-RM, +R, and +RW disks*

3 Terms and definitions

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

3.1

BER max

maximum byte error rate at any consecutive 32 ECC blocks on a disk as measured in the first pass of the decoder before correction

Note 1 to entry: BER max is applied to DVD-RAM disks.

Note 2 to entry: This note applies to the French language only.

3.2

B_{mig} Life

lifetime for use of data migration and identical to $B_{0,0001}$ Life which is 0,000 001 quantile of the lifetime distribution (i.e. 0,000 1 % failure time) or 99,999 9 % survival lifetime

3.3

B_5 Life

5 percentile of the lifetime distribution (i.e. 5 % failure time) or 95 % survival lifetime

3.4**(B_5 Life)_L**

95 % lower confidence bound of B_5 Life

3.5 **B_{50} Life**

50 percentile of the lifetime distribution (i.e. 50 % failure time) or 50 % survival lifetime

3.6**data migration**

process to copy data from one storage device or medium to another

3.7**error correction code****ECC**

mathematical computation yielding check bytes used for the detection and correction of errors in data

Note 1 to entry: For DVD-R, DVD-RW, DVD-RAM, +R, and +RW disks, the Reed-Solomon product code defined in ISO/IEC 16448:2002 for DVD-ROM systems is applied.

Note 2 to entry: This note applies to the French language only.

3.8**error rate**

rate of errors on the recorded disk measured before error correction is applied

3.9**initial performance test**

test of the recording performance of data recorded on a disk before storing

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3.10**lifetime**

time that information is retrievable in a system

3.11**PIE SUM 8 max**

maximum inner parity error at any consecutive 8 ECC blocks on a disk as measured in the first pass of the decoder before correction

Note 1 to entry: PIE SUM 8 max is applied to DVD-R, DVD-RW, +R, and +RW disks.

Note 2 to entry: This note applies to the French language only.

3.12**periodic performance test**

periodic test of the recording performance of data recorded on a disk during the storage

3.13**retrievability**

ability to recover physical information as recorded

3.14**substrate**

transparent layer of the disk, provided for mechanical support of the recording or recorded layer, through which the optical beam accesses the recordable/recorded layer

3.15 system

combination of hardware, software, storage medium and documentation used to record, retrieve and reproduce information

3.16 uncorrectable error

error in the playback data that could not be corrected by the error correcting decoders

3.17 X_{mig} Life

migration interval (year) determined by user

3.18 Controlled storage-condition

well-controlled storage conditions with full-time air conditioning (25 °C and 50 % RH) in which the lifetime of data stored on optical media may be extended

Note 1 to entry: Refer ISO/IEC 16963.

4 Disk and lifetime for long-term audio data storage

4.1 Disk for long-term audio data storage

A disk with a specified lifetime should be used for long-term audio data storage. A disk with an unspecified lifetime should not be used.

4.2 Lifetime estimation

For the purposes of this standard, the lifetime of a disk shall be derived from the measurements specified in ISO/IEC 16963. The Eyring method is used for lifetime estimation under Controlled storage conditions (25 °C /50 %RH).

In ISO/IEC 16963, the estimated lifetime can be defined variously as B_{50} Life, B_5 Life and the 95 % lower confidence bound of B_5 Life (= (B_5 Life)_L) and described as follows.

$$\begin{aligned} B_{50} \text{ Life} &= \exp(\ln \hat{B}_{50}) \\ &= \exp(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20}), \\ B_5 \text{ Life} &= \exp(\ln \hat{B}_5) \\ &= \exp(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20} - 1,64\hat{\sigma}), \end{aligned}$$

where, $\{x_{10}, x_{20}\}$ denotes the Controlled storage-condition (25 °C and 50 % RH).

Also, the 95 % lower confidence bound of B_5 Life becomes

$$(B_5 \text{ Life})_L \cong \exp(\ln \hat{B}_5 - 1,64\hat{\sigma}).$$

$\hat{\beta}_0$, $\hat{\beta}_1$, $\hat{\beta}_2$ and estimated variance of residual errors $\hat{\sigma}^2$ are obtained using regression analysis of time-to-failure data.

4.3 B_{mig} Life for long-term audio data storage

The estimated lifetime of B_5 Life means 5 % of the products reach failure. It is widely used in other contexts. However, from the viewpoint of the reliability of long-term audio storage to

retain the integrity of the original data, it is not appropriate to use B_5 Life as the estimated lifetime when determining a test interval and deciding on data migration.

In the case of audio data migration, it is necessary to have a sufficiently low failure probability. The time at which one millionth of the products reach failure shall define the estimated lifetime in this standard to determine test intervals and migration interval. $B_{0,000\ 1}$ Life is 0,000 001 quantile of the lifetime distribution (i.e. 0,000 1% failure time) and expressed as B_{mig} Life in this standard. B_{mig} Life can be calculated using B_{50} Life and B_5 Life as follows (see also Annex E in ISO/IEC 29121:2013)

$$B_{0,000\ 1}\text{Life} = \exp(\ln \hat{B}_{50} - 4,75\hat{\sigma}) = \exp\left(\ln \hat{B}_{50} - 4,75 \frac{\ln \hat{B}_{50} - \ln \hat{B}_5}{1,64}\right)$$

$$= \exp(2,9 \ln \hat{B}_5 - 1,9 \ln \hat{B}_{50})$$

Thus

$$B_{\text{mig}}\text{Life} = B_{0,000\ 1}\text{Life} = \exp(2,9 \ln \hat{B}_5 - 1,9 \ln \hat{B}_{50})$$

In actual storage conditions, the temperature and relative humidity may deviate from the Controlled storage-condition of 25 °C/50 % RH, which changes the estimated lifetime. In this case, the estimated lifetime should be adjusted according to the estimated lifetime at the actual storage conditions (see Annex D in ISO/IEC 29121:2013).

4.4 Estimated-lifetime rank and display colour

4.4.1 Estimated-lifetime rank and display colour identification

For audio data migration, rank of B_{mig} Life and its identifying display colour are defined as follows.

B_{mig} Life is over 30 years, the display colour is red.

B_{mig} Life is over 60 years, the display colour is green.

B_{mig} Life is over 100 years, the display colour is gold.

Guideline for use of the ranks of B_{mig} Life and their display colours are shown in Annex A.

4.4.2 B_{mig} Life and display colour indication on disks and packages

The rank of B_{mig} Life, its display colour and the reference Controlled storage-condition shall be indicated both on disk and package, excluding a two sided disk. Indication examples for ranks and their colours are shown in Annex A.

5 Test condition, test methods and disks for audio data migration

5.1 Ambient conditions for testing

When performing recordings or playbacks, the air immediately surrounding the disk should have the following properties:

Recording condition	20 °C to 45 °C
Playback condition	20 °C to 45 °C

5.2 Test methods

5.2.1 Playback test drive

The playback speed of the test drive should be:

for DVD-R, DVD-RW, +R format and +RW format disks	4 × CLV (constant linear velocity), or 6 × CLV
for DVD-RAM disk	2 × CAV (constant angular velocity), 3 × CAV, or 5 × CAV

5.2.2 Test area of recorded disk

The whole recorded data area should be tested.

In case of a DVD-RAM disk, the replaced data in the defect management area, instead of the defect data in the user area, should be tested.

5.2.3 Recording test drive

The recording speed of the test drive should be:

For DVD-R, DVD-RW, +R format and +RW format disks	4 × CLV or 6 × CLV
For a DVD-RAM disk	2 × CAV, 3 × CAV or 5 × CAV

The test drive should implement the multi-session and multi-border method for recordable disks and the DVD-RW rewritable disk. Archive data shall be recorded in the first session or border. The history information can be recorded on the second or subsequent session or border.

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The test drive should implement the incremental write method for the DVD-RAM and +RW format rewritable disks. Data can be written to the formatted disk by simply recording files. The history information can be recorded on the disk as additional file record.

5.3 Test drive calibration

The playback and recording test drive(s) shall be calibrated by using a calibration disk prepared by the test drive manufacturer and using the calibration procedure specified by the manufacturer. The calibration shall be done at the intervals recommended by the manufacturer.

6 Test result evaluation

6.1 Initial performance test result evaluation

When data are recorded on disks, the initial recording performance on the whole recorded area shall be checked. The initial recording performance shall be categorized as Level 1, 2 and 3 using PIE SUM 8 max for DVD-R, DVD-RW, +R, and +RW disks, and BER max for DVD-RAM as shown in Table 1.

At least, the initial recording performance shall be within Level 1. Disks showing the initial recording performance of Level 2 should not be used for long-term audio data storage, and those of Level 3 are out of the specification and shall not be used.

If the initial recording performance is worse than Level 1, the performance of the drive used for recording the data should be verified because PIE SUM 8 max and BER max depend on the performance of both disks and drives. If the drive is not good, the drive should be replaced. If the disk is not good, another batch of disks should be used.

Table 1 – Category of initial recording performance

Level	Status	DVD-R, DVD-RW, +R, +RW PIE SUM 8 max	DVD-RAM BER max
1	Recommended	<140	$<5,0 \times 10^{-4}$
2	Should not be used	140 to 280	$5,0 \times 10^{-4}$ to $1,0 \times 10^{-3}$
3	Shall not be used	>280	$>1,0 \times 10^{-3}$

6.2 Periodic performance test evaluation

Disks used for storing data should be periodically checked with the test interval described in Clause 6. The recording performance at the periodic performance test is categorized in Levels 4, 5 and 6 using PIE SUM 8 max for DVD-R, DVD-RW, +R, and +RW disks, and BER max for DVD-RAM as shown in Table 2.

If the recording performance is within Level 4, the disk is good enough to continue to be stored.

If the recording performance is within Level 5, the data stored on the disk shall be migrated to another disk as soon as possible.

If the recording performance is in Level 6, the data stored on the disk shall be copied to another disk immediately, as far as the data can be retrieved. Please note that in Level 6, PIE SUM 8 max and BER max are high enough that the retrieved data may contain uncorrectable errors.

Data migration flow for the initial performance test and periodic performance test is shown in Figure 1.

Table 2 – Category of recording performance at periodic performance test

Level	Status	DVD-R, DVD-RW, +R, +RW PIE SUM 8 max	DVD-RAM BER max
4	Use as it is	<200	$<7,1 \times 10^{-4}$
5	Migrate data as soon as possible	200 to 280	$7,1 \times 10^{-4}$ to $1,0 \times 10^{-3}$
6	Migrate data immediately	>280	$>1,0 \times 10^{-3}$

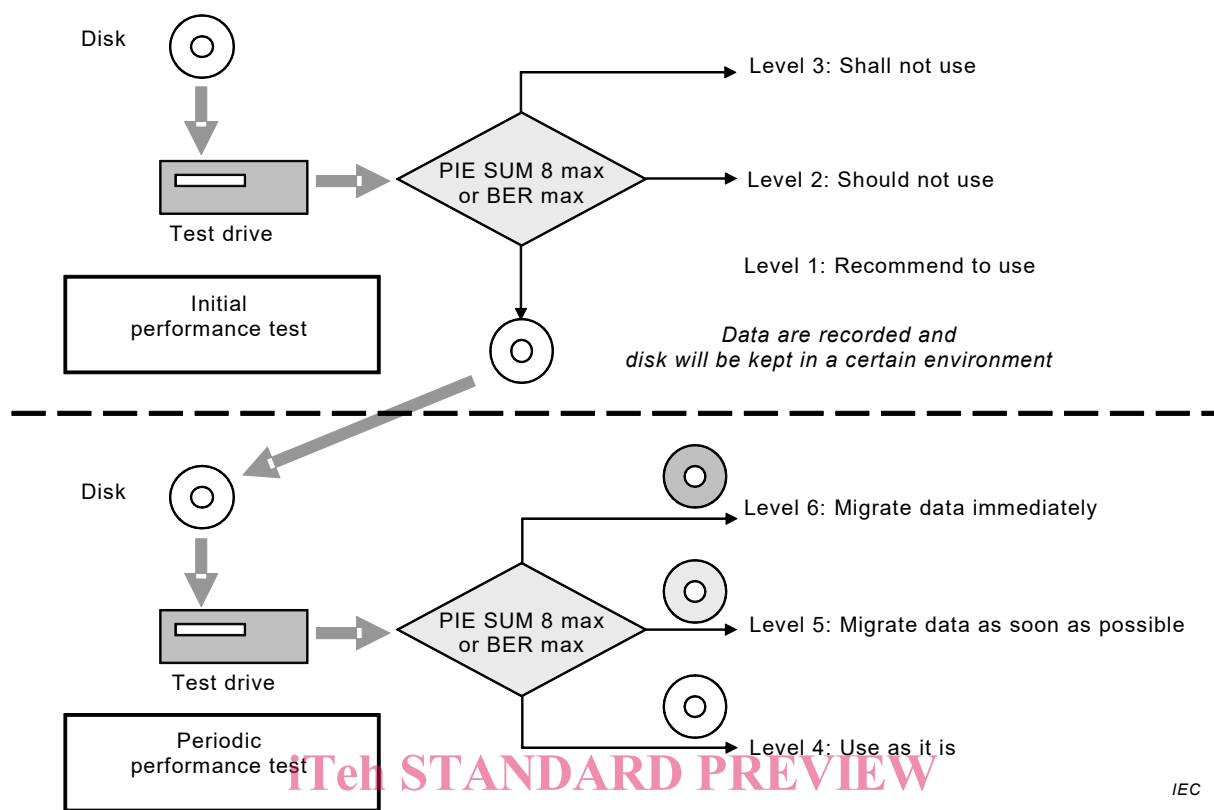


Figure 1 – Data migration flow for DVD-R, DVD-RW, DVD-RAM, +R, and +RW disks

6.3 Reporting items

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6.3.1 Initial performance test result

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The date and year of the initial test, the measured errors result and the evaluation result shall be reported as part of the history of this disk. The disk type and manufacturer name, the specified rank of disk, and the next testing year and date should be reported. Moreover, the test drive manufacturer, model name and serial number should be reported.

6.3.2 Periodic performance test result

At each periodic test, the date and year of the test, the measured errors result, and history of evaluation results shall be reported. The disk type and manufacturer name, and the specified rank of the disk should be reported. Moreover, the test drive manufacturer, model name and serial number should be reported.

6.4 Management of reporting item

Reporting items shall be reported to the host computer.

Reporting items should be recorded on the disk which can then be used (see Annex C).

6.5 Test and migration intervals

In this standard, the test interval between periodic performance tests shall be set at half of B_{mig} Life. Therefore the test interval for each rank of disk with display colour red, green and gold will be 15 years, 30 years and 50 years respectively.

If a disk with an unspecified lifetime is used, it should be tested every three years or less.