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Audio archive system – iTeh Standards
Part 1-2: BD disk and data migration for long-term audio data storage

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CONTENTS

FOREWORD	4
INTRODUCTION	2
1 Scope	7
2 Normative references	7
3 Terms and definitions and abbreviated terms	7
4 Disk and lifetime for long-term audio data storage	10
4.1 Disk for long-term audio data storage	10
4.2 Lifetime estimation	10
4.3 B_{mig} life for long-term audio data storage	10
4.4 Estimated-lifetime rank and display colour	12
4.4.1 Estimated-lifetime rank and display colour identification	12
4.4.2 B_{mig} life and display colour indication on disks and packages	12
5 Test condition, test methods and disks for audio data migration	12
5.1 Ambient conditions for testing of maximum data error measurement	12
5.2 Test methods	12
5.2.1 General	12
5.2.2 Max RSER	12
5.2.1 Playback test drive	12
5.2.2 Test area of recorded and sample disk	13
5.2.3 Recording test drive	13
5.2.4 Test drive calibration check	13
6 Test result evaluation	13
6.1 Initial performance test result evaluation	13
6.2 Periodic performance test result evaluation	14
6.3 Reporting items	16
6.3.1 Initial performance test result	16
6.3.2 Periodic performance test result	16
6.4 Management of reporting items	16
6.5 Test and migration intervals	16
7 Prevention of deterioration	17
Annex A (informative) Guidelines for usage and indication	18
A.1 Usage of lifetime rank	18
A.2 Lifetime rank indication and place	18
A.2.1 Lifetime rank indication	18
A.2.2 Indication example	18
Annex B (informative) Recommendations on handling, storage and cleaning conditions for BD writable disks	19
B.1 Handling	19
B.2 Storage	19
B.3 Cleaning	20
Annex C (informative) Causes of deterioration for BD disks for long-term data storage	21
C.1 Deterioration	21
C.2 Disk structure	21
C.3 Causes of deterioration	21
C.4 Nature of deterioration	22

C.5 Effects of deterioration 22

C.6 Unexpected deterioration 22

Bibliography 23

Figure 1 – Data migration flow for the initial and the periodic performance tests 15

Figure A.1 – ~~Lifetime rank~~ Indication example 18

Table 1 – Category of initial recording performance 13

Table 2 – Category of recording performance at periodic performance test 14

Table B.1 – Recommended conditions for general storage 19

Table B.2 – Recommended conditions for controlled storage 19

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 (<https://standards.itih.ai>)
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

AUDIO ARCHIVE SYSTEM –

Part 1-2: BD disk and data migration for long-term audio data storage

FOREWORD

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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition IEC 62702-1-2:2017. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

IEC 62702-1-2 has been prepared by technical area 6: Storage media, storage data structures, storage systems and equipment, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2017. This edition constitutes a technical revision.

In order to reflect the updates to ISO/IEC 29121:2021, this edition includes the following significant technical changes with respect to the previous edition:

- a) ISO/IEC 16963 has been identified as the referee test method for the estimation of lifetime;
- b) the ambient conditions for the measurement of maximum data error have been added;
- c) the requirements for test drives have been changed considering the use condition of users;
- d) the requirements for the estimated lifetime have been defined more clearly;
- e) the requirements for the periodic performance test have been defined more clearly.

The text of this International Standard is based on the following documents:

Draft	Report on voting
100/3671/CDV	100/3743/RVC

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

The language used for the development of this International Standard is English.

A list of all parts in the IEC 62702 series, published under the general title *Audio archive system*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 recording system, the phonautograph, was invented by Édouard-Léon Scott de Martinville in 1860 and, after that, Thomas Alva Edison invented the recording and playback system known as the phonograph in 1877.

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

The progress of LSI (Large-Scale Integrated Circuit) technology made digital recording of recorded sound possible. 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 non-volatile memory (such as phase-change memory).

This International Standard specifies physical and logical aspects for standards of audio archives of various storage types which are typically used for audio archives on the market.

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.

NOTE DVD optical disks include DVD-R disk, DVD-RW disk, DVD-RAM disk and +R format disk, +RW format disk. BD optical disks include BD recordable disk and BD rewritable disk.

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

AUDIO ARCHIVE SYSTEM –

Part 1-2: BD 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 BD disks (hereafter referred to as "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 BD recordable disk and BD rewritable disk.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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/IEC 16963:2017, *Information technology – Digitally recorded media for information interchange and storage – Test method for the estimation of lifetime of optical disks for long-term data storage*

ISO/IEC 29121:2017/2021, *Information technology – Digitally recorded media for information interchange and storage – Data migration method for optical disks for long-term data storage*

~~ISO/IEC 30190:2016, Information technology – Digitally recorded media for information interchange and storage – 120 mm Single Layer (25,0 Gbytes per disk) and Dual Layer (50,0 Gbytes per disk) BD Recordable disk~~

~~ISO/IEC 30191, Information technology – Digitally recorded media for information interchange and storage – 120 mm Triple Layer (100,0 Gbytes single sided disk and 200,0 Gbytes double sided disk) and Quadruple Layer (128,0 Gbytes single sided disk) BD Recordable disk~~

~~ISO/IEC 30192, Information technology – Digitally recorded media for information interchange and storage – 120 mm Single Layer (25,0 Gbytes per disk) and Dual Layer (50,0 Gbytes per disk) BD Rewritable disk~~

~~ISO/IEC 30193, Information technology – Digitally recorded media for information interchange and storage – 120 mm Triple Layer (100,0 Gbytes per disk) BD Rewritable disk~~

3 Terms and definitions and abbreviated terms

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

~~3.1 Terms and definitions~~

3.1

B_{mig} life

lifetime (3.10) for use of *data migration* (3.6) and identical to $B_{0,000\ 1}$ life which is 0,000 001 quantile of the *lifetime* distribution (i.e. 0,000 1 % failure time) or 99,999 9 % survival ~~lifetime distribution (i.e. 0,000 1 % failure time) or 99,999 9 % survival lifetime~~

[SOURCE: ISO/IEC 29121:2017/2021, 3.1, ~~modified — Note 1 to entry deleted.~~]

3.2

B_5 life

5 percentile of the *lifetime* (3.10) distribution (i.e. 5 % failure time) or 95 % survival lifetime

[SOURCE: ISO/IEC 16963:2017, 3.4]

3.3

$(B_5 \text{ life})_L$

95 % lower confidence bound of *B_5 life* (3.2)

[SOURCE: ISO/IEC 16963:2017, 3.5]

3.4

B_{50} life

50 percentile of the *lifetime* (3.10) distribution (i.e. 50 % failure time) or 50 % survival lifetime

[SOURCE: ISO/IEC 16963:2017, 3.6]

3.5

controlled storage condition

well-controlled storage conditions with full-time air conditioning (25 °C and 50 % relative humidity) in which ~~can extend~~ the *lifetime* (3.10) of data stored on optical disks

[SOURCE: ISO/IEC 16963:2017, 3.7]

3.6

data migration

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

[SOURCE: ISO/IEC 29121:2017/2021, 3.5]

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 BD recordable disk and BD rewritable disks, the long-distance code (LDC) + burst-indicating subcode (BIS) defined in ISO/IEC 30190, ISO/IEC 30191, ISO/IEC 30192, and ISO/IEC 30193 is applied.

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

[SOURCE: ISO/IEC 29121:2021, 3.6 modified— Note 1 to entry has been shortened to apply only to BD disks.]

**3.8
error rate**

rate of errors or error count ~~on the recorded disk~~ measured ~~before~~ on the signal at the input of error-correction decoder ~~is applied~~, which represents raw-error rate of data recorded on a disk

[SOURCE: ISO/IEC 29121:2017/2021, 3.7]

**3.9
initial performance test**

first test of the ~~recording performance~~ error rate (3.8) of data recorded on a disk before storing

[SOURCE: ISO/IEC 29121:2017/2021, 3.8]

**3.10
lifetime**

time that information is retrievable in a *system* (3.16)

[SOURCE: ISO/IEC 29121: 2017/2021, 3.9]

**3.11
maximum data error**

greatest level of *error rate* (3.8) anywhere in one of the relevant areas on the disk

[SOURCE: ISO/IEC 16963:2017, 3.13, modified — Note 1 to entry has been deleted.]

**3.12
RSE_{Rmax}**

greatest level of random symbol error rate measured on the signal in one of the relevant areas on a disk at the input of error-correction decoder, which excludes burst errors of length greater than or equal to 40 bytes

Note 1 to entry: See ISO/IEC 30190, ISO/IEC 30191, ISO/IEC 30192, ISO/IEC 30193 and ISO/IEC 16963.

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

**3.13
periodic performance test**

periodic test of the ~~recording performance~~ error rate (3.8) of data recorded on a disk during the storage

[SOURCE: ISO/IEC 29121:2017/2021, 3.15]

**3.14
retrievability**

ability to recover physical information as recorded

[SOURCE: ~~ISO/IEC 29121:2017, 3.16~~ ISO/IEC 16963:2017, 3.14]

**3.15
substrate**

layer, which can be transparent or not, provided for the mechanical support of a recording layer

[SOURCE: ISO/IEC 30193:2021, 3.43]

**3.16
system**

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

[SOURCE: ISO/IEC 16963:2017, 3.20]

**3.17
uncorrectable error**

error in the ~~playback~~ read-out data that ~~could not~~ cannot be corrected by the error ~~correcting~~ correction decoders

[SOURCE: ISO/IEC 29121:2017/2021, 3.18]

**3.18
X_{mig} Life interval**

migration interval (year) which is determined by user

[SOURCE: ISO/IEC 29121:2017/2021, 3.19, modified — Note 1 to entry has been deleted.]

3.2 — Abbreviated terms

~~Max RSER~~ ————— ~~Max Random Symbol Error Rate~~

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 document, 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 and 50 % relative humidity).

In ISO/IEC 16963:2017, the estimated lifetime can be defined variously as B_{50} life, B_5 life and the 95 % lower confidence bound of B_5 life [equals $(B_5 \text{ life})_L$] and is described as follows.

$$B_{50 \text{ life}} = \exp(\ln \hat{B}_{50}) = \exp(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20})$$

$$B_{5 \text{ life}} = \exp(\ln \hat{B}_5) = \exp(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20} - 1,64\hat{\sigma})$$

where

$B_{50 \text{ life}}$ is the variable for B_{50} life;

$B_5 \text{ life}$ is the variable for B_5 life;

x_{10} and x_{20} are the temperature-dependent factor and the relative-humidity-dependent factor at the controlled storage conditions (25 °C/50 % relative humidity) respectively.

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

$$B_{(5 \text{ life})L} = \exp\left[\left(\ln \hat{B}_5\right)_L\right] = \exp\left[\ln \hat{B}_5 - 1,64\sqrt{\text{var}\left(\ln \hat{B}_5\right)}\right]$$

where

$B_{(5 \text{ life})L}$ is the variable for $(B_5 \text{ life})_L$;

$\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2$ and estimated variance of residual errors $\hat{\sigma}$ 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 the failure shall define, in this document, the estimated lifetime 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 document. B_{mig} life can be calculated using B_{50} life and B_5 life as follows (see also ISO/IEC 29121:2017, Annex E).

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

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

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

where

$B_{0,000\ 1} \text{ life}$ is the variable for $B_{0,000\ 1} \text{ life}$.

Thus

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

$$B_{\text{mig}} \text{ life} \times 24 \times 365 = B_{0,000\ 1} \text{ life} = \exp\left(2,9 \ln \hat{B}_5 - 1,9 \ln \hat{B}_{50}\right)$$

where

$B_{\text{mig}} \text{ life}$ is the variable for $B_{\text{mig}} \text{ life}$.

In actual storage conditions, the temperature and relative humidity can deviate from the controlled storage condition of 25 °C and 50 % relative humidity, which changes the estimated lifetime. In this case, the estimated lifetime should be adjusted according to the estimated lifetime at the actual storage conditions, as specified in ISO/IEC 29121:2017/2021, Annex D.

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.

Guidelines 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 on both the disk and the packaging, 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 of maximum data error measurement

~~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.~~

The ambient condition is the surrounding condition in a room where a test drive is located. The ambient conditions for the RSER_{max} measurements are as follows:

Temperature: 15 °C to 30 °C

Relative humidity: 20 % to 75 %

5.2 Test methods

5.2.1 General

~~The necessity of data migration is checked in the initial performance test and the periodic performance tests. When data is recorded on disks, the initial recording performance on the whole recorded area shall be examined as the initial performance test. The recording performance of data recorded on a disk during storage should be periodically examined with the test interval described in 6.5 as the periodic performance tests.~~

5.2.2 Max RSER

~~Maximum random SER (max RSER) shall be measured on the test area of the recorded disk, where max RSER is applied to BD Recordable SL/DL disks, BD Recordable TL/QL disks, BD Rewritable SL/DL disks and BD Rewritable TL disks defined in ISO/IEC 30190, ISO/IEC 30191, ISO/IEC 30192 and ISO/IEC 30193 respectively.~~