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Edition 2.0 2022-06
REDLINE VERSION

INTERNATIONAL STANDARD

colour inside

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

IEC 62702-1-2:2022-06 RLV(en)

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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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 life)$_L$
95 % lower confidence bound of B_5 *life* (3.2)

[SOUECE: 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
$RSER_{max}$
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 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.

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

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

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

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

where

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

$\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2$ 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~~2021, Annex E).

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

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

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

where

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

Thus

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

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

where

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

5.2.1 Playback test drive

For BD recordable disks and BD rewritable disks, the test drive shall have capability to measure $RSER_{max}$.

The test drive shall have the capability to evaluate the error rate level specified in the initial performance test and the periodic performance test.

NOTE The measuring circuit for random symbol error rate (RSER) described in ISO/IEC 30191 and ISO/IEC 30193 is different from that described in ISO/IEC 30190 and ISO/IEC 30192, especially for the HF signal pre-processing circuit. See ISO/IEC 30190:~~2016~~2021, Annex H, and ISO/IEC 30191:2021, Annex H, for additional information.

5.2.2 Test area ~~of recorded~~ and sample disk

The test area is the recorded area to be tested in a disk.

The whole recorded ~~data~~ area of all disks shall be tested for the initial performance test.

The whole recorded area of all disks should be tested for the periodic performance test. Although the integrity of the data becomes lower, the user may reduce the test area and/or the number of sample disks based on a certain sampling method, considering the value of information (see ISO/IEC 29121:2021, Annex G). For the reduction of test area, see ISO/IEC 16963:2017, 7.5 for additional information. The number of sample disks should be enough to guarantee statistical effectiveness. If the sample disks have different attributes such as disk standards, recording conditions or storage conditions, the disks should be divided into groups of disks considering the attributes so that the sampling can be applied on each group with statistical effectiveness.

5.2.3 Recording test drive

There are two cases for the test drive. The first that the drive serves both as a test drive and a recorder that records the data on the disk. The second is that the test drive is different from the recorder. For both cases, the data recorded on the disk by the recorder shall fulfil the error rate level specified in the initial performance test and the periodic performance test.

5.2.4 Test drive ~~calibration~~ check

~~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.~~

The test drive shall be checked by using a reference disk prepared by the test drive manufacturer or the disk prepared by the user, so that it fulfils the requirements in 5.2.1, 5.2.2 and 5.2.3. When using a reference disk prepared by the test drive manufacturer, the check of the test drive shall be done at the intervals recommended by the manufacturer. When using a disk prepared by the user, it is recommended for the user to set an appropriate interval and to check the test drive at the interval.

6 Test result evaluation

6.1 Initial performance test result evaluation

~~The initial performance test result shall be judged by Max RSER, and~~ The initial recording performance ~~is~~ shall be categorized as Levels 1, 2 ~~and~~ or 3 ~~by Max RSER~~ using $RSER_{max}$ for BD recordable disk and BD rewritable disk as shown Table 1.

As a minimum, the initial recording performance ~~should~~ shall be within the limits of Level 1. Disks showing the initial recording performance of Level 2 should not be used for long-term

audio data storage, ~~. Disks showing the initial recording performance~~ 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 ~~disk and~~ drive used for recording the data should be verified because ~~Max RSER~~ $RSER_{max}$ depends on the performance of both disks and drives. If ~~the drive does not have~~ the performance ~~required~~ of the drive is not good, the drive should be replaced. If ~~the disk does not have~~ the performance ~~required~~ of the disk is not good, another ~~lot~~ batch of disks should be used.

Table 1 – Category of initial recording performance

Level	Status	~~Max RSER~~ BD recordable BD rewritable
1	Recommended	$< 5{,}0 \times 10^{-4}$
2	Should not be used	$5{,}0 \times 10^{-4}$ to $1{,}0 \times 10^{-3}$
3	Shall not be used	$> 1{,}0 \times 10^{-3}$
Maximum data error		$RSER_{max}$

6.2 Periodic performance test result evaluation

~~The periodic performance test result shall be judged by Max RSER, and the recording performance at the periodic performance test is categorized as Level 4, 5 and 6 by Max RSER as shown in Table 2.~~

Disks used for storing data should be periodically checked with the test interval described in 6.5. The recording performance at the periodic performance test is categorized in Levels 4, 5 or 6 using $RSER_{max}$ for BD recordable disks and BD rewritable disks, as shown in Table 2.

If the recording performance is within Level 4, the disk is good enough to continue to be ~~used~~ 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 ~~Max RSER~~ in Level 6 ~~is~~, $RSER_{max}$ are high enough ~~to disable retrieval of~~ that the retrieved data ~~without~~ can contain uncorrectable errors.

Table 2 – Category of recording performance at periodic performance test

Level	Status	~~Max RSER~~ BD recordable BD rewritable
4	Use as is	$< 7{,}1 \times 10^{-4}$
5	Migrate data as soon as possible	$7{,}1 \times 10^{-4}$ to $1{,}0 \times 10^{-3}$
6	Migrate data immediately	$>1{,}0 \times 10^{-3}$
Maximum data error		$RSER_{max}$

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

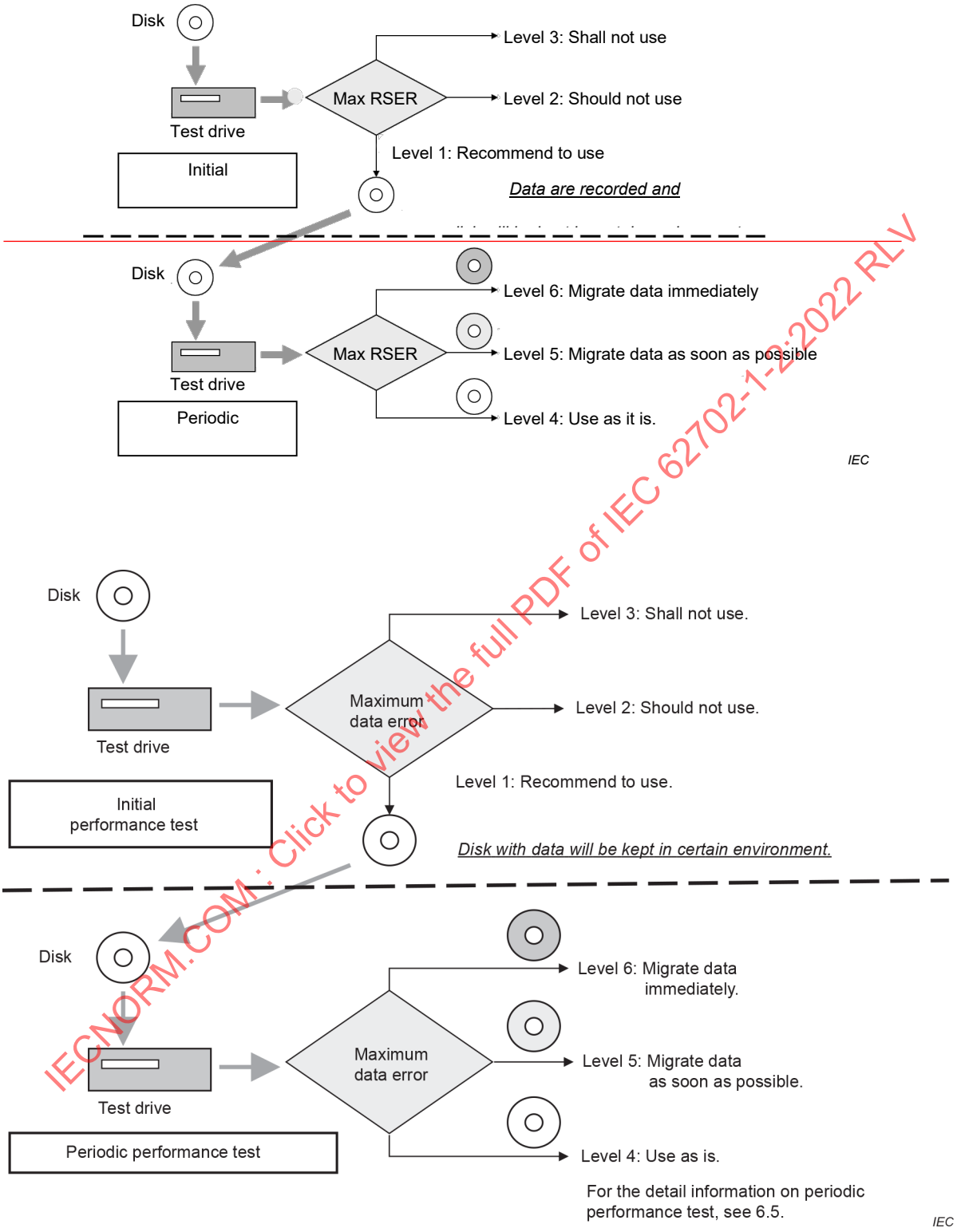

Figure 1 – Data migration flow for the initial and the periodic performance tests

6.3 Reporting items

6.3.1 Initial performance test result

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 items

Reporting items shall be reported to the host computer.

Reporting items should be recorded on the disk.

6.5 Test and migration intervals

In this document, the test interval between periodic performance tests is set at a half of B_{mig} life. Therefore, the test interval for each rank of disk with displayed colours 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.~~

If B_{mig} life is not available as shown below, the test interval should be three years or less. A greater test interval causes the risk of data loss and failure in the data migration. If such a risk is unacceptable, the test interval of three years or less is strongly recommended.

– The estimated lifetime data is not provided.

– The estimated lifetime data is provided but lacks statistical accuracy.

Generational changes of the system, including reading devices, file structures and applications, which occur during the normal migration interval can affect readability in addition to the quality of the disk itself. For safety, or if the stored data has high value, the user may choose shorter intervals for testing and migration.

In consideration of these factors, the migration interval is defined as X_{mig} ~~(years)~~ interval and this value shall be determined by the user of this part (see ISO/IEC 29121:2021, Annex F).

X_{mig} is the variable for X_{mig} interval, and $B_{mig\ life}$ is the variable for B_{mig} life in years.

Actual test intervals and data migration using $B_{mig\ life}$ ~~(herein after B_{mig})~~ and X_{mig} are as follows.

a) If $X_{mig} - B_{mig\ life}/2$ is larger than 0, then the test interval of the first periodic performance test is $B_{mig\ life}/2$ years, and the storage is continued. ~~See Annex F in ISO/IEC 29121:2017.~~

b) If $X_{mig} - B_{mig\ life}/2$ is less than or equal to 0, then the test interval of the first periodic performance test is X_{mig} ~~(years)~~, and the data migration is carried out regardless of the test result.

If the test interval is very long, for instance over ten years, a sampling check of the stored disks should be carried out at shorter intervals. The occurrence of retrievability problems or long read times can indicate an immediate need for detailed testing.

When tests indicate deterioration of one disk, additional tests may be performed on other disks of the same type, age, or batch to ascertain their condition. Replacement of all similarly affected disks should be considered if such additional tests indicate significant problems.

7 Prevention of deterioration

Necessary precautions shall be taken to reduce the possibility of deterioration, in order to ensure the integrity of the disks during their use, storage, handling, or transportation~~, which are indicated in Annex B~~. Causes of deterioration and their effects are indicated in Annex C. For long-term audio storage, the recommendations in Annex B should be implemented.

Annex A
(informative)

Guidelines for usage and indication

A.1 Usage of lifetime rank

This annex describes how to choose the disk rank which is most desirable as audio information storage.

a) Display colour: red (indicated B_{mig} life is over 30 years)

   A disk of this rank may be used for general purpose storage of audio information.

b) Display colour: green (indicated B_{mig} life is over 60 years)

   A disk of this rank may be used for long-term audio information storage or important audio information.

c) Display colour: gold (indicated B_{mig} life is over 100 years)

   A disk of this rank may be used for especially important audio information or historically valuable audio information.

A.2 Lifetime rank indication and place

A.2.1 Lifetime rank indication

Disk and/or disk packages should display the specified lifetime rank and display colour. Two-sided disks should display the specified lifetime rank and display colour on the packaging only

A.2.2 Indication example

Figure A.1 shows typical indication examples together with B_{mig} life, display colour and storage condition for reference.

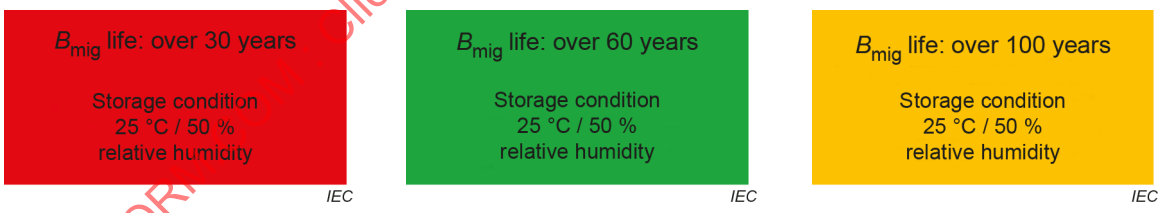

Figure A.1 – ~~Lifetime rank~~ Indication example

Annex B
(informative)

Recommendations on handling, storage and cleaning conditions for BD writable disks

B.1 Handling

Disks intended for long-term audio storage should not be left in readers, or remain exposed to light, corrosive atmospheres or solvents, or to extremes of temperature or humidity.

The fragile protective coating on the label surface is vulnerable to damage and should be protected together with the readout surface. Carefully handle the disk, touching only the outer edge and inner hole. Never touch the readout surface.

Disks should not be subjected to mechanical stresses that might tend to distort the disk.

Disks should be protected from dust and debris. This is especially important for recordable and rewritable disks during the recording process. The use of a deionizing environment is recommended to neutralize static charges on the disk that can attract and retain loose contaminants.

B.2 Storage

For temporary storage such as in an office environment, the storage environment should be limited to the ranges given in Table B.1.

Table B.1 – Recommended conditions for general storage

Ambient condition	Recommended range
Temperature	5 °C to 30 °C
Relative humidity	15 % to 80 %
Absolute humidity	1 g/m^3 to 24 g/m^3
Atmospheric pressure	75 kPa to 106 kPa
Temperature gradient	10 °C per hour maximum
Relative humidity gradient	10 % per hour maximum

For long-term storage, conditions should be more tightly controlled, and the storage environment should be limited to the ranges given in Table B.2.

Table B.2 – Recommended conditions for controlled storage

Ambient condition	Recommended range
Temperature	10 °C to 25 °C
Relative humidity	30 % to 50 %
Absolute humidity	3 g/m^3 to 12 g/m^3
Atmospheric pressure	75 kPa to 106 kPa
Temperature gradient	10 °C per hour maximum
Relative humidity gradient	10 % per hour maximum

Conditions that could form condensation of moisture on the disk should be avoided. Cool and dry storage conditions are preferred. To maintain the desirable temperature and humidity fluctuation tolerance levels, and to protect against high-intensity light and pollutants, BD writable disks should be stored vertically in clean insulated containers. Dust or debris in operational or storage locations should be minimized by appropriate maintenance and monitoring procedures, especially when recording disks.

B.3 Cleaning

Prior to performing cleaning operations of disks containing useful data, tests should be carried out on disks of the same type and from the same supplier that do not contain any useful data, in order to ensure that no adverse reaction will occur.

Loose contaminants ~~may~~ can be removed by short, one-second bursts of clean, dry air, avoiding expulsion of cold propellants. If the manufacturer has not supplied any cleaning information, organic polymer substrate disks can be cleaned using a lint-free cloth of a non-woven fabric and either clean or soapy water. It is recommended not use detergents or solvents such as alcohol. All wiping actions should be in a radial direction, taking care not to exert isolated pressure or to scratch the disks. It is strongly recommended not to use abrasives. It is recommended not to use acrylic liquids, waxes, or other coatings on either surface.

~~NOTE: This annex applies to BD disks only. See Annex B in ISO/IEC 29121:2017.~~

Annex C
(informative)

Causes of deterioration for BD disks for long-term data storage

C.1 Deterioration

BD disks for long-term data storage are composed of recording layers and reflective layers. Deterioration of the recording and reflective layers can occur in the following environments:

– storage at high temperature and/or high humidity;
– storage under sunlight or UV light;
– storage in a high density of corrosive gases (hydrogen sulphide, etc.);
– storage in fluctuating environments (temperature change, humidity change, etc.).

In addition, the laser incident surface can be damaged or contaminated during use.

This deterioration will increase the error rate of disks.

C.2 Disk structure

BD recordable and BD rewritable disks comprise a recording substrate covered with recording, reflective and over-coating resin layers.

BD recordable and BD rewritable disks adopt an inorganic phase-change recording layer. For some types of BD recordable disks, an organic dye recording layer is also used instead of an inorganic phase-change recording layer.

C.3 Causes of deterioration

Recording and reflective layers can deteriorate during long-term storage in an extreme environment, as indicated in Clause C.1.

Recording layers can be degraded by corrosion, cracking, decomposition, etc. As a result, reflectivity and quality of recording signals are degraded. Recorded marks can also be deformed during long-term storage in such an extreme environment. In the case of phase-change disks, amorphous recorded marks can be partially crystallized at random, and then fluctuations of the rim and change of the reflectivity of each mark can occur. Those phenomena result in a reduction of the signal modulation or an increase in the jitter noise. In the case of dye-type disks, a recorded mark is formed with a change in the refractive index of the dye material or with physical deformation of the substrate material. Upon receiving environmental stress, discolouring of the dye material or a relaxation of the physical deformation can occur. Those phenomena also result in the reduction of signal modulation or an increase in jitter noise. Reflective layers can be degraded by corrosion, cracking, decomposition, etc. As a result, reflectivity and the quality of recording signals are degraded.

As with all optical disks, small defects are allowed at the time of manufacture. Over a long period of time, under extreme environmental exposure, these defects can grow. The growth of defects as well as the deterioration of recording and reflective layers as mentioned above can be shown to follow Arrhenius's law, and this method can be used to confirm the predicted lifetime of optical disks for long-term data storage.

Storage in fluctuating environments can also degrade mechanical property, such as tilt, and axial or radial runout.

Damage or contamination on the laser-incident surface can obscure the recording layer and create dropouts in the data. Additionally, particulate damage or contamination can 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 casual cleaning of disks using unapproved materials and procedures. Cleaning of disks should only be carried out in accordance with the procedures contained in Annex B.

C.4 Nature of deterioration

The operating environment will determine the nature of the deterioration. In the case of disks used in a library, this environment is well controlled; however, operation of disks in stand-alone drives will potentially subject the disks to a wider range of contamination and environmental extremes. In particular, disks left in uncontrolled storage can be subject to physical abuse or contamination in contravention of the manufacturers' recommendations.

C.5 Effects of deterioration

The combination of beam obscuration and possible disturbance of the servo signals will generate a dropout in the data reaching the decoder. While the ECC (error correction code) has a very high burst correction capability, a large dust particle can cause this capability to be exceeded.

C.6 Unexpected deterioration

For protection from unexpected serious deterioration of the disks, it is recommended to have a backup system for the long-term data storage according to the characteristics and importance of the data.

~~NOTE: This annex applies to BD disks only. See Annex A in ISO/IEC 29121:2017.~~

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~~White Paper Blu-ray Disc™ Format General 4th Edition, August, 2015 Available from http://www.blu-raydisc.com/Assets/Downloadablefile/White_Paper_General_4th_20150817_clean.pdf~~

ISO/IEC 30190:2021, *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 30191:2021, *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*

IEC 62702-1-2

Edition 2.0 2022-06

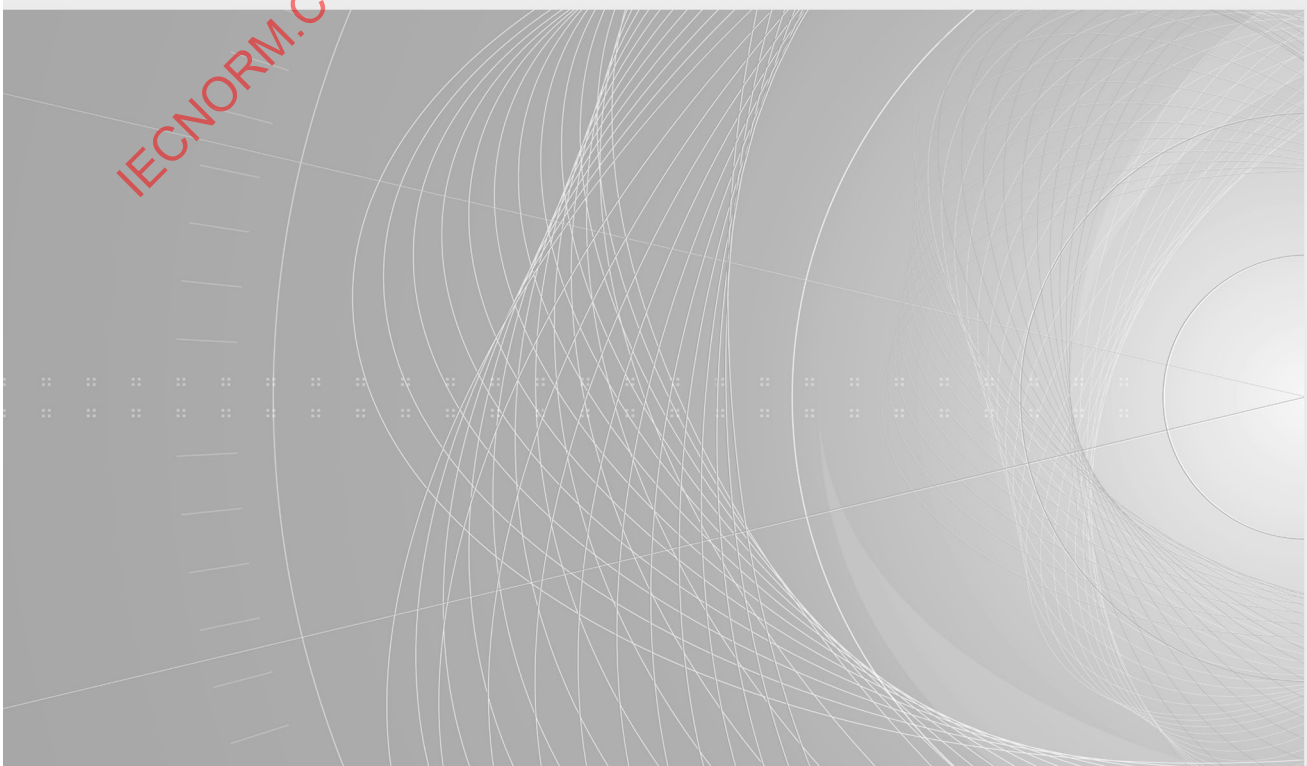
INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

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

Système d'archivage audio –
Partie 1-2: Disque BD et migration de données pour le stockage à long terme des données audio



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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

AUDIO ARCHIVE SYSTEM –

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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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 29121:2021, *Information technology – Digitally recorded media for information interchange and storage – Data migration method for optical disks for long-term data storage*

3 Terms and definitions

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
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

[SOURCE: ISO/IEC 29121:2021, 3.1]

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 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 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 29121:2021, 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 measured on the signal at the input of error-correction decoder, which represents raw error rate of data recorded on a disk

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

3.9
initial performance test
first test of the *error rate* (3.8) of data recorded on a disk before storing

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

3.10
lifetime
time that information is retrievable in a *system* (3.16)

[SOURCE: ISO/IEC 29121:2021, 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
$RSER_{max}$
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 *error rate* (3.8) of data recorded on a disk during the storage

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

3.14
retrievability
ability to recover physical information as recorded

[SOURCE: 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 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 read-out data that cannot be corrected by the error correction decoders

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

3.18
X_{mig} interval
migration interval (year) which is determined by user

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

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, 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.

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

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

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

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

where

$B_{(5\ \text{life})\text{L}}$ 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 29121:2021, Annex E).

$$B_{0,000\ 1\ \text{life}} = \exp\left(\ln\hat{B}_{0,0001}\right) = \exp\left(\ln\hat{B}_{50} - 4,75\hat{\sigma}\right) = \exp\left(\ln\hat{B}_{50} - 4,75\frac{\ln\hat{B}_{50} - \ln\hat{B}_{5}}{1,64}\right) =$$

$$\exp\left(2,9\ln\hat{B}_{5} - 1,9\ln\hat{B}_{50}\right)$$

where

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

Thus

$$B_{\text{mig life}} \times 24 \times 365 = B_{0,000\ 1\ \text{life}} = \exp\left(2,9\ln\hat{B}_{5} - 1,9\ln\hat{B}_{50}\right)$$

where

$B_{\text{mig life}}$ is the variable for B_{mig} 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 29121:2021, 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

5.1 Ambient conditions of maximum data error measurement

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 Playback test drive

For BD recordable disks and BD rewritable disks, the test drive shall have capability to measure $RSER_{max}$.

The test drive shall have the capability to evaluate the error rate level specified in the initial performance test and the periodic performance test.

NOTE The measuring circuit for random symbol error rate (RSER) described in ISO/IEC 30191 and ISO/IEC 30193 is different from that described in ISO/IEC 30190 and ISO/IEC 30192, especially for the HF signal pre-processing circuit. See ISO/IEC 30190:2021, Annex H, and ISO/IEC 30191:2021, Annex H, for additional information.

5.2.2 Test area and sample disk

The test area is the recorded area to be tested in a disk.

The whole recorded area of all disks shall be tested for the initial performance test.

The whole recorded area of all disks should be tested for the periodic performance test. Although the integrity of the data becomes lower, the user may reduce the test area and/or the number of sample disks based on a certain sampling method, considering the value of information (see ISO/IEC 29121:2021, Annex G). For the reduction of test area, see ISO/IEC 16963:2017, 7.5 for additional information. The number of sample disks should be enough to guarantee statistical effectiveness. If the sample disks have different attributes such as disk standards, recording conditions or storage conditions, the disks should be divided into groups of disks considering the attributes so that the sampling can be applied on each group with statistical effectiveness.

5.2.3 Recording test drive

There are two cases for the test drive. The first that the drive serves both as a test drive and a recorder that records the data on the disk. The second is that the test drive is different from the recorder. For both cases, the data recorded on the disk by the recorder shall fulfil the error rate level specified in the initial performance test and the periodic performance test.

5.2.4 Test drive check

The test drive shall be checked by using a reference disk prepared by the test drive manufacturer or the disk prepared by the user, so that it fulfils the requirements in 5.2.1, 5.2.2 and 5.2.3. When using a reference disk prepared by the test drive manufacturer, the check of the test drive shall be done at the intervals recommended by the manufacturer. When using a disk prepared by the user, it is recommended for the user to set an appropriate interval and to check the test drive at the interval.

6 Test result evaluation

6.1 Initial performance test result evaluation

The initial recording performance shall be categorized as Levels 1, 2 or 3 using $RSER_{max}$ for BD recordable disk and BD rewritable disk as shown Table 1.

As a minimum, the initial recording performance shall be within the limits of 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 $RSER_{max}$ depends on the performance of both

disks and drives. If the performance of the drive is not good, the drive should be replaced. If the performance of the disk is not good, another batch of disks should be used.

Table 1 – Category of initial recording performance

Level	Status	BD recordable BD rewritable
1	Recommended	$< 5{,}0 \times 10^{-4}$
2	Should not be used	$5{,}0 \times 10^{-4}$ to $1{,}0 \times 10^{-3}$
3	Shall not be used	$> 1{,}0 \times 10^{-3}$
Maximum data error		$RSER_{max}$

6.2 Periodic performance test result evaluation

Disks used for storing data should be periodically checked with the test interval described in 6.5. The recording performance at the periodic performance test is categorized in Levels 4, 5 or 6 using $RSER_{max}$ for BD recordable disks and BD rewritable disks, 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, $RSER_{max}$ are high enough that the retrieved data can contain uncorrectable errors.

Table 2 – Category of recording performance at periodic performance test

Level	Status	BD recordable BD rewritable
4	Use as is	$< 7{,}1 \times 10^{-4}$
5	Migrate data as soon as possible	$7{,}1 \times 10^{-4}$ to $1{,}0 \times 10^{-3}$
6	Migrate data immediately	$>1{,}0 \times 10^{-3}$
Maximum data error		$RSER_{max}$

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

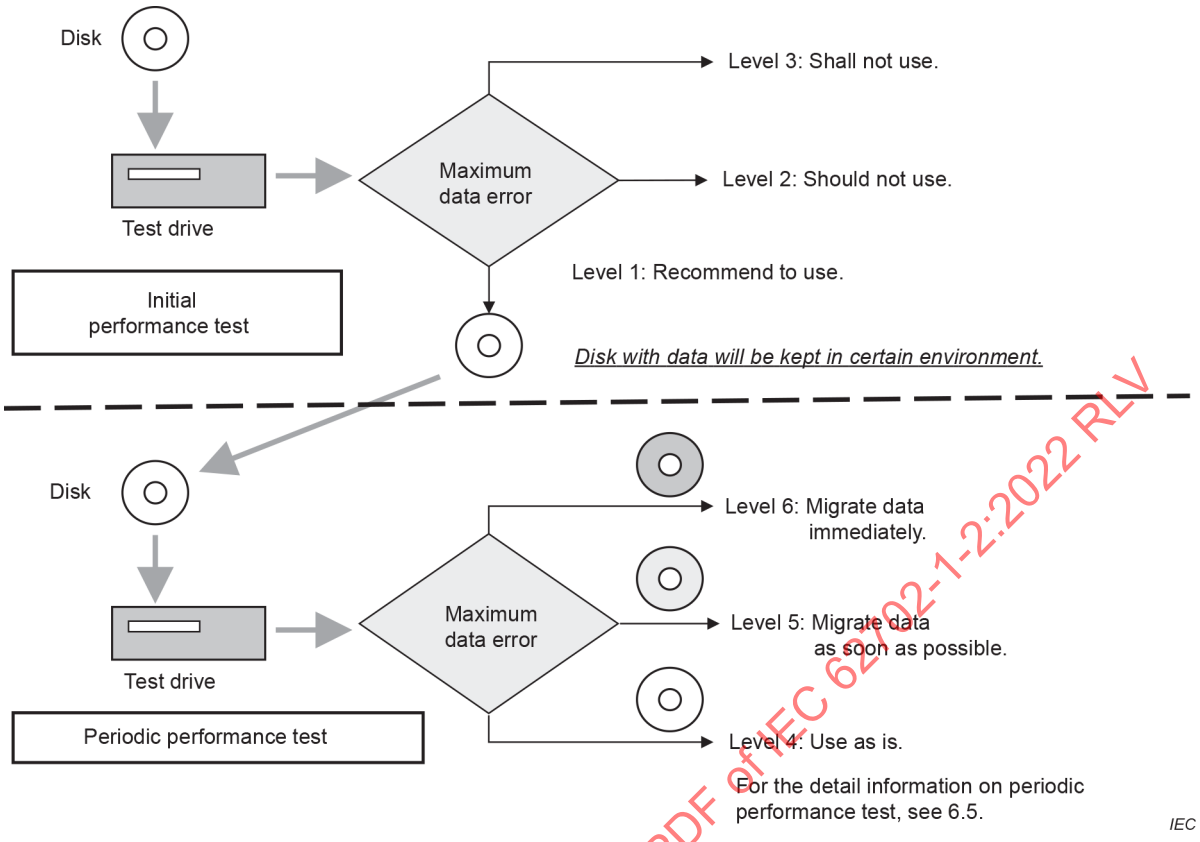

Figure 1 – Data migration flow for the initial and the periodic performance tests

6.3 Reporting items

6.3.1 Initial performance test result

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 items

Reporting items shall be reported to the host computer.

Reporting items should be recorded on the disk.

6.5 Test and migration intervals

In this document, the test interval between periodic performance tests is set at a half of B_{mig} life. Therefore, the test interval for each rank of disk with displayed colours red, green and gold will be 15 years, 30 years and 50 years respectively.

If B_{mig} life is not available as shown below, the test interval should be three years or less. A greater test interval causes the risk of data loss and failure in the data migration. If such a risk is unacceptable, the test interval of three years or less is strongly recommended.

– The estimated lifetime data is not provided.

– The estimated lifetime data is provided but lacks statistical accuracy.

Generational changes of the system, including reading devices, file structures and applications, which occur during the normal migration interval can affect readability in addition to the quality of the disk itself. For safety, or if the stored data has high value, the user may choose shorter intervals for testing and migration.

In consideration of these factors, the migration interval is defined as X_{mig} interval and this value shall be determined by the user of this part (see ISO/IEC 29121:2021, Annex F).

X_{mig} is the variable for X_{mig} interval, and $B_{mig\ life}$ is the variable for B_{mig} life in years.

Actual test intervals and data migration using $B_{mig\ life}$ and X_{mig} are as follows.

a) If $X_{mig} - B_{mig\ life}/2$ is larger than 0, then the test interval of the first periodic performance test is $B_{mig\ life}/2$ years, and the storage is continued.

b) If $X_{mig} - B_{mig\ life}/2$ is less than or equal to 0, then the test interval of the first periodic performance test is X_{mig}, and the data migration is carried out regardless of the test result.

If the test interval is very long, for instance over ten years, a sampling check of the stored disks should be carried out at shorter intervals. The occurrence of retrievability problems or long read times can indicate an immediate need for detailed testing.

When tests indicate deterioration of one disk, additional tests may be performed on other disks of the same type, age, or batch to ascertain their condition. Replacement of all similarly affected disks should be considered if such additional tests indicate significant problems.

7 Prevention of deterioration

Necessary precautions shall be taken to reduce the possibility of deterioration, in order to ensure the integrity of the disks during their use, storage, handling, or transportation. Causes of deterioration and their effects are indicated in Annex C. For long-term audio storage, the recommendations in Annex B should be implemented.

Annex A
(informative)

Guidelines for usage and indication

A.1 Usage of lifetime rank

This annex describes how to choose the disk rank which is most desirable as audio information storage.

a) Display colour: red (indicated B_{mig} life is over 30 years)

   A disk of this rank may be used for general purpose storage of audio information.

b) Display colour: green (indicated B_{mig} life is over 60 years)

   A disk of this rank may be used for long-term audio information storage or important audio information.

c) Display colour: gold (indicated B_{mig} life is over 100 years)

   A disk of this rank may be used for especially important audio information or historically valuable audio information.

A.2 Lifetime rank indication and place

A.2.1 Lifetime rank indication

Disk and/or disk packages should display the specified lifetime rank and display colour. Two-sided disks should display the specified lifetime rank and display colour on the packaging only

A.2.2 Indication example

Figure A.1 shows typical indication examples together with B_{mig} life, display colour and storage condition for reference.

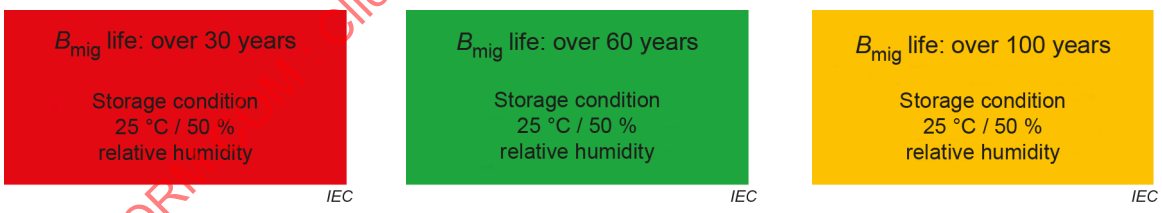

Figure A.1 – Indication example

Annex B
(informative)

Recommendations on handling, storage and cleaning conditions for BD writable disks

B.1 Handling

Disks intended for long-term audio storage should not be left in readers, or remain exposed to light, corrosive atmospheres or solvents, or to extremes of temperature or humidity.

The fragile protective coating on the label surface is vulnerable to damage and should be protected together with the readout surface. Carefully handle the disk, touching only the outer edge and inner hole. Never touch the readout surface.

Disks should not be subjected to mechanical stresses that might tend to distort the disk.

Disks should be protected from dust and debris. This is especially important for recordable and rewritable disks during the recording process. The use of a deionizing environment is recommended to neutralize static charges on the disk that can attract and retain loose contaminants.

B.2 Storage

For temporary storage such as in an office environment, the storage environment should be limited to the ranges given in Table B.1.

Table B.1 – Recommended conditions for general storage

Ambient condition	Recommended range
Temperature	5 °C to 30 °C
Relative humidity	15 % to 80 %
Absolute humidity	1 g/m^3 to 24 g/m^3
Atmospheric pressure	75 kPa to 106 kPa
Temperature gradient	10 °C per hour maximum
Relative humidity gradient	10 % per hour maximum

For long-term storage, conditions should be more tightly controlled, and the storage environment should be limited to the ranges given in Table B.2.

Table B.2 – Recommended conditions for controlled storage

Ambient condition	Recommended range
Temperature	10 °C to 25 °C
Relative humidity	30 % to 50 %
Absolute humidity	3 g/m^3 to 12 g/m^3
Atmospheric pressure	75 kPa to 106 kPa
Temperature gradient	10 °C per hour maximum
Relative humidity gradient	10 % per hour maximum

Conditions that could form condensation of moisture on the disk should be avoided. Cool and dry storage conditions are preferred. To maintain the desirable temperature and humidity fluctuation tolerance levels, and to protect against high-intensity light and pollutants, BD writable disks should be stored vertically in clean insulated containers. Dust or debris in operational or storage locations should be minimized by appropriate maintenance and monitoring procedures, especially when recording disks.

B.3 Cleaning

Prior to performing cleaning operations of disks containing useful data, tests should be carried out on disks of the same type and from the same supplier that do not contain any useful data, in order to ensure that no adverse reaction will occur.

Loose contaminants can be removed by short, one-second bursts of clean, dry air, avoiding expulsion of cold propellants. If the manufacturer has not supplied any cleaning information, organic polymer substrate disks can be cleaned using a lint-free cloth of a non-woven fabric and either clean or soapy water. It is recommended not use detergents or solvents such as alcohol. All wiping actions should be in a radial direction, taking care not to exert isolated pressure or to scratch the disks. It is strongly recommended not to use abrasives. It is recommended not to use acrylic liquids, waxes, or other coatings on either surface.

Annex C
(informative)

Causes of deterioration for BD disks for long-term data storage

C.1 Deterioration

BD disks for long-term data storage are composed of recording layers and reflective layers. Deterioration of the recording and reflective layers can occur in the following environments:

– storage at high temperature and/or high humidity;
– storage under sunlight or UV light;
– storage in a high density of corrosive gases (hydrogen sulphide, etc.);
– storage in fluctuating environments (temperature change, humidity change, etc.).

In addition, the laser incident surface can be damaged or contaminated during use.

This deterioration will increase the error rate of disks.

C.2 Disk structure

BD recordable and BD rewritable disks comprise a recording substrate covered with recording, reflective and over-coating resin layers.

BD recordable and BD rewritable disks adopt an inorganic phase-change recording layer. For some types of BD recordable disks, an organic dye recording layer is also used instead of an inorganic phase-change recording layer.

C.3 Causes of deterioration

Recording and reflective layers can deteriorate during long-term storage in an extreme environment, as indicated in Clause C.1.

Recording layers can be degraded by corrosion, cracking, decomposition, etc. As a result, reflectivity and quality of recording signals are degraded. Recorded marks can also be deformed during long-term storage in such an extreme environment. In the case of phase-change disks, amorphous recorded marks can be partially crystallized at random, and then fluctuations of the rim and change of the reflectivity of each mark can occur. Those phenomena result in a reduction of the signal modulation or an increase in the jitter noise. In the case of dye-type disks, a recorded mark is formed with a change in the refractive index of the dye material or with physical deformation of the substrate material. Upon receiving environmental stress, discolouring of the dye material or a relaxation of the physical deformation can occur. Those phenomena also result in the reduction of signal modulation or an increase in jitter noise. Reflective layers can be degraded by corrosion, cracking, decomposition, etc. As a result, reflectivity and the quality of recording signals are degraded.

As with all optical disks, small defects are allowed at the time of manufacture. Over a long period of time, under extreme environmental exposure, these defects can grow. The growth of defects as well as the deterioration of recording and reflective layers as mentioned above can be shown to follow Arrhenius's law, and this method can be used to confirm the predicted lifetime of optical disks for long-term data storage.

Storage in fluctuating environments can also degrade mechanical property, such as tilt, and axial or radial runout.

Damage or contamination on the laser-incident surface can obscure the recording layer and create dropouts in the data. Additionally, particulate damage or contamination can 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 casual cleaning of disks using unapproved materials and procedures. Cleaning of disks should only be carried out in accordance with the procedures contained in Annex B.

C.4 Nature of deterioration

The operating environment will determine the nature of the deterioration. In the case of disks used in a library, this environment is well controlled; however, operation of disks in stand-alone drives will potentially subject the disks to a wider range of contamination and environmental extremes. In particular, disks left in uncontrolled storage can be subject to physical abuse or contamination in contravention of the manufacturers' recommendations.

C.5 Effects of deterioration

The combination of beam obscuration and possible disturbance of the servo signals will generate a dropout in the data reaching the decoder. While the ECC (error correction code) has a very high burst correction capability, a large dust particle can cause this capability to be exceeded.

C.6 Unexpected deterioration

For protection from unexpected serious deterioration of the disks, it is recommended to have a backup system for the long-term data storage according to the characteristics and importance of the data.

Bibliography

ISO/IEC 30190:2021, *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 30191:2021, *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*

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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SYSTÈME D'ARCHIVAGE AUDIO –

Partie 1-2: Disque BD et migration de données pour le stockage à long terme des données audio

AVANT-PROPOS

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L'IEC 62702-1-2 a été établie par le domaine technique 6: Média de stockage, structures des données, équipements et systèmes, du comité d'études 100 de l'IEC: Systèmes et équipements audio, vidéo et services de données. Il s'agit d'une Norme internationale.

Cette deuxième édition annule et remplace la première édition parue en 2017. Cette édition constitue une révision technique.

Afin de refléter les mises à jour apportées à l'ISO/IEC 29121:2021, cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) l'ISO/IEC 16963 a été identifiée comme méthode d'essai de référence pour l'estimation de la durée de vie;

b) des conditions ambiantes ont été ajoutées pour le mesurage de l'erreur de données maximale;

c) les exigences relatives aux unités d'essai ont été modifiées en fonction des conditions d'utilisation des utilisateurs;

d) les exigences relatives à la durée de vie estimée ont été définies de manière plus précise;

e) les exigences relatives à l'essai périodique de performances ont été définies de manière plus précise.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
100/3671/CDV	100/3743/RVC

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Une liste de toutes les parties de la série IEC 62702, publiées sous le titre général *Système d'archivage audio*, se trouve sur le site web de l'IEC.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/standardsdev/publications.

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INTRODUCTION

Les enregistrements sonores tels que la musique, la parole et les récits constituent un héritage humain important qu'il convient de préserver le plus longtemps possible. Toutefois, par le passé, les sons ne pouvaient pas être enregistrés à des fins de préservation. Inventé par Édouard-Léon Scott de Martinville en 1860, le phonautographe est le premier système conçu pour enregistrer les sons. Le premier système d'enregistrement et de lecture, le phonographe, a été inventé en 1877 par Thomas Alva Edison.

Même si différentes technologies ont été inventées par la suite, la plupart d'entre elles ont leurs limites en ce qui concerne l'archivage audio; la durée de vie du stockage est limitée, et la qualité du son se détériore lors de son transfert sur les dispositifs de stockage de nouvelle génération.

Les progrès de la technologie d'intégration à grande échelle (LSI, *Large-Scale Integrated*) ont rendu possible l'enregistrement numérique du son. L'enregistrement numérique est parfaitement adapté à l'archivage audio, car la migration est réalisée en copiant les données numériques.

À cette fin, il existe différents supports d'enregistrement tels que les disques optiques, les disques magnétiques, les bandes magnétiques et la mémoire non volatile (comme la mémoire à variation de phase).

Le présent document spécifie les aspects physiques et logiques des normes relatives aux archivages audio de différents types de stockages, habituellement utilisés pour les archivages audio sur le marché.

La série IEC 62702 se compose actuellement des parties suivantes:

- La Partie 1 spécifie les exigences minimales relatives aux aspects physiques des disques optiques pour les enregistrements sonores numériques. La Partie 1-1 spécifie les disques optiques DVD (Digital Versatile Disc), tandis que la Partie 1-2 spécifie les disques optiques BD (Blu-ray Disc).

  NOTE Les disques optiques DVD incluent les disques DVD-R, DVD-RW, DVD-RAM, le format +R et le format +RW. Les disques optiques BD incluent les disques enregistrables BD et les disques réenregistrables BD.

- La Partie 2 spécifie les exigences minimales relatives à la numérisation du contenu, au format du contenu numérisé, aux informations du contenu et à l'inspection du support.

SYSTÈME D'ARCHIVAGE AUDIO –

Partie 1-2: Disque BD et migration de données pour le stockage à long terme des données audio

1 Domaine d'application

La présente partie de l'IEC 62702 spécifie une méthode d'assurance de la qualité des données pour les disques BD inscriptibles (ci-après dénommés "disques") qui sont spécifiés pour le stockage à long terme des données, ainsi qu'une méthode de migration des données capable de conserver les données enregistrées sur les disques de manière à assurer la conservation à long terme des données audio. Les disques inscriptibles incluent les disques enregistrables BD (Blu-ray Disk) et les disques réenregistrables BD.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

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* (disponible en anglais seulement)

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

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse https://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse https://www.iso.org/obp

3.1
durée de vie B_{mig}
durée de vie (3.10) d'utilisation de la *migration de données* (3.6) identique à la durée de vie $B_{0,000\ 1}$, qui correspond à 0,000 001 quantile de la répartition des durées de vie (soit 0,000 1 % de temps de défaillance) ou 99,999 9 % de temps de survie

[SOURCE: ISO/IEC 29121:2021, 3.1]

3.2
durée de vie B_5
5 centiles de la répartition des *durées de vie* (3.10) (soit 5 % de temps de défaillance) ou 95 % de temps de survie

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

3.3
(durée de vie B_5)$_L$
limite de confiance inférieure de 95 % de la *durée de vie* B_5 (3.2)

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

3.4
durée de vie B_{50}
50 centiles de la répartition des *durées de vie* (3.10) (soit 50 % de temps de défaillance) ou 50 % de temps de survie

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

3.5
condition de stockage contrôlée
conditions de stockage bien contrôlées avec une climatisation permanente (25 °C et 50 % d'humidité relative) pour la *durée de vie* (3.10) des données stockées sur les disques optiques

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

3.6
migration de données
processus de copie des données d'un dispositif ou d'un support de stockage sur un autre

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

3.7
code de correction d'erreur
ECC
calcul mathématique qui donne les octets de contrôle utilisés pour la détection et la correction d'erreurs dans les données

Note 1 à l'article: Pour les disques enregistrables BD et les disques réenregistrables BD, le code longue distance (LDC, *Long-Distance Code*) et le sous-code d'indication de salve (BIS, *Burst-Indicating Subcode*) défini dans l'ISO/IEC 30190, l'ISO/IEC 30191, l'ISO/IEC 30192, et l'ISO/IEC 30193 s'appliquent.

Note 2 à l'article: Le terme abrégé "ECC" est dérivé du terme anglais développé correspondant "error correction code".

[SOURCE: ISO IEC 29121:2021, 3.6, modifié – La Note 1 à l'article a été raccourcie pour ne s'appliquer qu'aux disques BD.]

3.8
taux d'erreurs
taux d'erreurs ou nombre d'erreurs mesuré sur le signal à l'entrée du décodeur de correction d'erreurs, qui représente le taux d'erreurs brutes des données enregistrées sur un disque

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

3.9
essai initial de performances
premier essai du *taux d'erreurs* (3.8) des données enregistrées sur un disque avant le stockage

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

3.10
durée de vie
durée pendant laquelle les informations sont récupérables à partir d'un *système* (3.16)

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

3.11
erreur de données maximale
plus haut niveau de *taux d'erreurs* (3.8) à un emplacement donné dans l'une des zones pertinentes du disque

[SOURCE: ISO IEC 16963:2017, 3.13, modifié – La Note 1 à l'article a été supprimée.]

3.12
$RSER_{max}$
plus haut niveau de taux d'erreurs de symbole aléatoires mesuré sur le signal dans l'une des zones pertinentes d'un disque à l'entrée du décodeur de correction d'erreurs, ce qui exclut les erreurs de salves de longueur supérieure ou égale à 40 octets

Note 1 à l'article: Voir l'ISO/IEC 30190, l'ISO/IEC 30191, l'ISO/IEC 30192, l'ISO/IEC 30193 et l'ISO/IEC 16963.

Note 2 à l'article: Le terme abrégé "RSER" est dérivé du terme anglais développé correspondant "random symbol error rate".

3.13
essai périodique de performances
essai périodique du *taux d'erreurs* (3.8) des données enregistrées sur un disque pendant le stockage

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

3.14
récupérabilité
aptitude à récupérer des informations physiques enregistrées

[SOURCE: ISO/IEC 16963:2017, 3.14]

3.15
substrat
couche, qui peut être transparente, fournie pour assurer le support mécanique d'une couche d'enregistrement

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

3.16
système
combinaison de matériel, de logiciel, de support de stockage et de documentation, utilisée pour l'enregistrement, la récupération et la reproduction d'informations

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

3.17
erreur non corrigeable
erreur dans les données de lecture qui ne peut pas être corrigée par les décodeurs de correction d'erreurs

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

3.18
intervalle X_{mig}
intervalle (année) de migration déterminé par l'utilisateur

[SOURCE: ISO IEC 29121:2021, 3.19, modifié – La Note 1 à l'article a été supprimée.]

4 Disque et durée de vie pour le stockage à long terme des données audio

4.1 Disque pour le stockage à long terme des données audio

Il convient d'utiliser un disque d'une durée de vie spécifiée pour le stockage à long terme des données audio. Il convient de ne pas utiliser un disque dont la durée de vie n'est pas spécifiée.

4.2 Estimation de la durée de vie

Pour les besoins du présent document, la durée de vie d'un disque doit être déduite des mesurages spécifiés dans l'ISO/IEC 16963. La méthode d'Eyring est utilisée pour estimer la durée de vie dans les conditions de stockage contrôlées (25 °C et 50 % d'humidité relative).

Dans l'ISO/IEC 16963, la durée de vie estimée peut être définie de différentes manières comme la durée de vie B_{50}, la durée de vie B_5 et la limite de confiance inférieure de 95 % de la durée de vie B_5 [qui équivaut à (durée de vie $B_5)_L$]; celle-ci est décrite ci-dessous.

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

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

où

$B_{50\ \text{life}}$ est la variable pour la durée de vie B_{50};

$B_{5\ \text{life}}$ est la variable pour la durée de vie B_5;

x_{10} et x_{20} sont le facteur dépendant de la température et le facteur dépendant de l'humidité relative dans les conditions de stockage contrôlées (25 °C et 50 % d'humidité relative), respectivement.

De même, la limite de confiance inférieure de 95 % de la durée de vie B_5 devient

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

où

$B_{(5\ \text{life})\text{L}}$ est la variable pour (durée de vie $B_5)_L$;

$\hat{\beta}_0, \hat{\beta}_1, \hat{\beta}_2$ et la variance estimée des erreurs résiduelles $\hat{\sigma}$ sont obtenus par l'analyse de régression des données de durée de fonctionnement avant défaillance.

4.3 Durée de vie B_{mig} pour le stockage à long terme des données audio

La durée de vie estimée de B_5 signifie que 5 % des produits sont défaillants. Elle est largement utilisée dans d'autres contextes. Toutefois, du point de vue de la fiabilité du stockage audio à