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INTERNATIONAL STANDARD

colour inside

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

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FOREWORD

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International Standard 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.

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

CDV	Report on voting
100/2894/CDV	100/2970/RVC

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

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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 a long term as much as possible. However, we were not able to record sounds in order to preserve them in the past. The first recoding was achieved by Edison in 1877.

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

The progress of LSI (Large-Scale Integrated Circuit) technology made digital recording of recorded sound possible. The digital recording is very suitable for audio archiving because the migration is performed by copying digital data.

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

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

The IEC 62702 series currently consists of:

– IEC 62702-1, which specifies the minimum requirements on physical aspects of optical disks for digital sound recordings; IEC 62702-1-1 specifies requirements for DVD optical disks, IEC 62702-1-2 specifies requirements for BD optical disks.

– IEC 62702-2, which specifies the minimum requirements for digitization of content, format of digitized 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 62702-1 specifies a method of data-quality assurance for writable disks (hereinafter "disks") which are specified for long-term data storage, and a data migration method, which can sustain the recorded data on disks for long-term audio data preservation. The writable disks include 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, *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, 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 http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Terms and definitions

3.1.1
B_{mig} Life
lifetime for use of data migration 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, 3.1, modified – Note 1 to entry deleted.]

3.1.2
B_5 Life
5 percentile of the lifetime distribution (i.e. 5 % failure time) or 95 % survival lifetime

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

3.1.3
$(B_5$ Life$)_L$
95 % lower confidence bound of B_5 Life

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

3.1.4
B_{50} Life
50 percentile of the lifetime distribution (i.e. 50 % failure time) or 50 % survival lifetime

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

3.1.5
Controlled storage-condition
well-controlled storage conditions with full-time air conditioning (*Temp*=25 °C and *RH*= 50 %) which can extend the lifetime of data stored on optical disks

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

3.1.6
data migration
process to copy data from one storage device or medium to another

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

3.1.7
error rate
rate of errors on the recorded disk measured before error correction is applied

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

3.1.8
initial performance test
test of the recording performance of data recorded on a disk before storing

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

3.1.9
lifetime
time that information is retrievable in a system

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

3.1.10
periodic performance test
periodic test of the recording performance of data recorded on a disk during the storage

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

3.1.11
retrievability
ability to recover physical information as recorded

[SOURCE: ISO/IEC 29121:2017, 3.16]

3.1.12
system
combination of hardware, software, storage medium and documentation used to record, retrieve and reproduce information

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

3.1.13
uncorrectable error
error in the playback data that could not be corrected by the error correcting decoders

[SOURCE: ISO/IEC 29121:2017, 3.19]

3.1.14
X_{mig} Life
X_{mig}
migration interval (year) that is determined by user

[SOURCE: ISO/IEC 29121:2017, 3.20, modified – Note 1 to entry 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 part, 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 (temperature = 25 °C and RH = 50 %).

In A.1.4 of 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 (= $(B_5 \text{ Life})_L$) and is described as follows.

B_{50} Life = $\exp(\ln \hat{B}_{50})$

= $\exp(\hat{\beta}_0 + \hat{\beta}_1 x_{10} + \hat{\beta}_2 x_{20})$,

B_5 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, (x_{10}, x_{20}) denotes the controlled storage conditions (temperature = 25 °C and RH = 50 %). $\hat{\beta}_0$, $\hat{\beta}_1$, $\hat{\beta}_2$ and estimated variance of residual errors $\hat{\sigma}$ are obtained using regression analysis of time-to-failure data.

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

$$(B_5 \text{ Life})_L = \exp[(\ln \hat{B}_5)_L] = \exp[\ln \hat{B}_5 - 1{,}64\sqrt{\text{var}(\ln \hat{B}_5)}\,].$$

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 the estimated lifetime in this document 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 Annex E in ISO/IEC 29121:2017):

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

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

Thus

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

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

4.4 Estimated lifetime rank and display colour

4.4.1 Estimated lifetime rank and display colour identification

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

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

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

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

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

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

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

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

5.1 Ambient conditions for testing

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

Recording condition: 20 °C to 45 °C;

Playback condition: 20 °C to 45 °C.

5.2 Test methods

5.2.1 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.

NOTE The measuring circuit for RSER described in ISO/IEC 30191 and ISO/IEC 30193 is different from that of described in ISO/IEC 30190 and ISO/IEC 30192, especially in HF signal pre-processing circuit. See ISO/IEC 30190:2016, Annex H and ISO/IEC 30191.

5.2.3 Test area of recorded disk

The whole recorded data area shall be tested.

5.3 Test drive calibration

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

6 Test result evaluation

6.1 Initial performance test result evaluation

The initial performance test result shall be judged by Max RSER, and the initial recording performance is categorized as Level 1, 2 and 3 by Max RSER as shown in Table 1. As a minimum, the initial recording performance should be within Level 1. Disks showing the initial recording performance of Level 2 should not be used. Disks showing the initial recording performance of Level 3 are out of the specifications 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 depends on the performance of both disks and drives. If the drive does not have the performance required, the drive should be replaced. If the disk does not have the performance required, another lot of disks should be used.

Table 1 – Category of initial recording performance

Level	Status	Max RSER
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	$> 1{,}0 \times 10^{-3}$

6.2 Periodic performance test 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. If the recording performance is within Level 4, the disk is good enough to continue to be used.

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 high enough to disable retrieval of the data without uncorrectable errors.

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

Table 2 – Category of recording performance at periodic performance

Level	Status	Max RSER
4	Use as it is	$< 7{,}1 \times 10^{-4}$
5	Migrate data as soon as possible	7,1 × 10-4 to $1{,}0 \times 10^{-3}$
6	Migrate data immediately	$> 1{,}0 \times 10^{-3}$

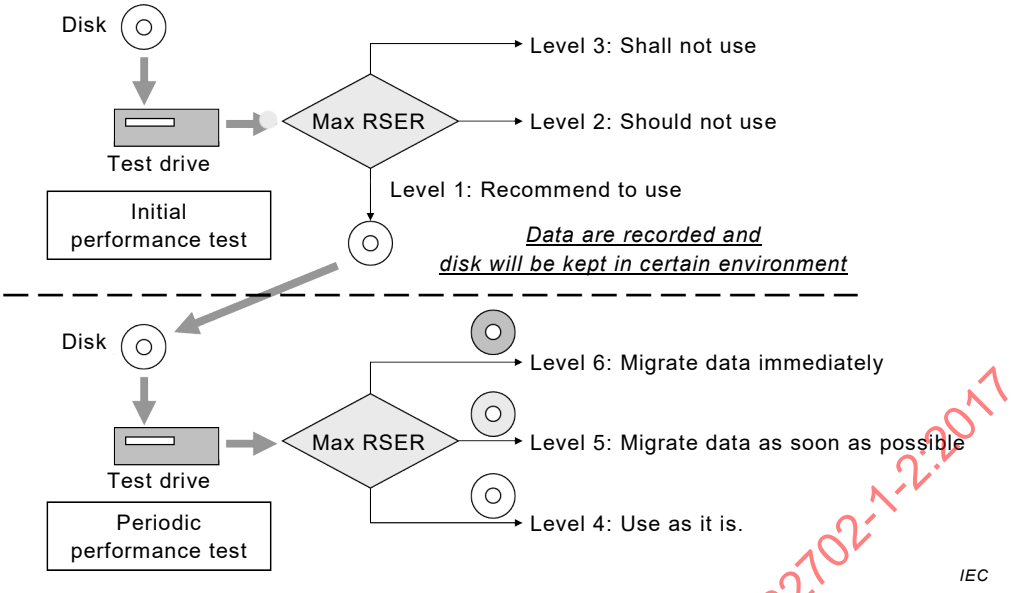

Figure 1 – Data migration flow for the initial and the periodic performance tests

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 host computer.

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.

Generational changes of the system, including reading devices, the file structures and applications, that 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) and this value shall be determined by the user of this document.

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

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

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

If the test interval is very long, 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 assure 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.

Annex A
(informative)

Guideline of 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 specifically 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 packages 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.

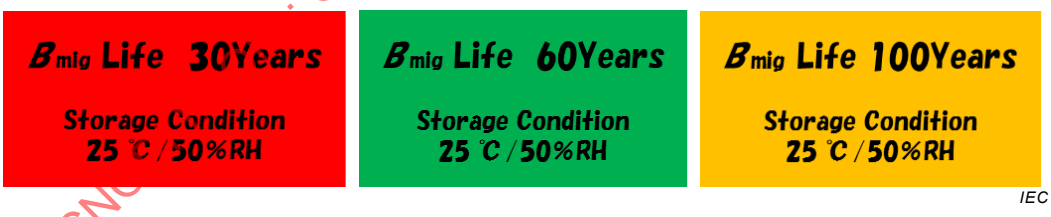

Figure A.1 – Lifetime rank indication example

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 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.