
**Information technology — Digitally
recorded media for information
interchange and storage — Test method
for the estimation of the archival lifetime
of optical media**

*Technologies de l'information — Supports enregistrés numériquement
pour l'échange et le stockage d'information — Méthode d'essai pour
l'estimation de la durée de vie d'archivage des supports optiques*

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 10995 was prepared by Ecma International (as ECMA-379) and was adopted, under a special “fast-track procedure”, by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

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Introduction

Markets and industry have developed the common understanding that the property referred to as the archival life of data recorded to optical media plays an increasingly important role for the intended applications. The existing standard test methodologies for recordable media include magneto-optical media and recordable compact disk systems. It was agreed that the project represented by this International Standard be undertaken in order to provide a methodology that includes the testing of newer, currently available products.

The Optical Storage Technology Association (OSTA) initiated work on this subject and developed the initial drafts. Following that development, the project was moved to Ecma International TC 31 for further development and finalization. OSTA and Ecma wish to thank the members and organizations in NIST, CDs21 Solutions, and DCAj for their support of the development of this International Standard.

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Information technology — Digitally recorded media for information interchange and storage — Test method for the estimation of the archival lifetime of optical media

1 Scope

This International Standard specifies an accelerated aging test method for estimating the life expectancy for the retrievability of information stored on recordable or rewritable optical disks.

This test includes details on the following formats: DVD-R/-RW/-RAM, +R/+RW. It may be applied to additional optical disk formats with the appropriate specification substitutions and may be updated by committee in the future as required.

This International Standard includes the following:

- stress conditions;
- assumptions;
- ambient conditions:
 - controlled storage condition, e.g. 25 °C and 50 % RH, using the Eyring model,
 - uncontrolled storage condition, e.g. 30 °C and 80 % RH, using the Arrhenius model;
- evaluation system description;
- specimen preparation;
- data acquisition procedure;
- data interpretation.

The methodology includes only the effects of temperature (T) and relative humidity (RH). It does not attempt to model degradation due to complex failure mechanism kinetics, nor does it test for exposure to light, corrosive gases, contaminants, handling, and variations in playback subsystems. Disks exposed to these additional sources of stress or higher levels of T and RH are expected to experience shorter usable lifetimes.

2 Conformance

Media tested by this methodology shall conform to all normative references specific to that media format.

3 Normative references

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

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

ISO/IEC 16449:2002, *Information technology — 80 mm DVD — Read-only disk*

ISO/IEC 17341:2006, *Information technology — Data Interchange on 120 mm and 80 mm Optical Disk using +RW Format – Capacity: 4,7 Gbytes and 1,46 Gbytes per Side (Recording speed up to 4X)*

ISO/IEC 17342:2004, *Information technology — 80 mm (1,46 Gbytes per side) and 120 mm (4,70 Gbytes per side) DVD re-recordable disk (DVD-RW)*

ISO/IEC 17344:2006, *Information technology — Data Interchange on 120 mm and 80 mm Optical Disk using +R Format – Capacity: 4,7 Gbytes and 1,46 Gbytes per Side (Recording speed up to 16X)*

ISO/IEC 17592:2004, *Information technology — 120 mm (4,7 Gbytes per side) and 80 mm (1,46 Gbytes per side) DVD rewritable disk (DVD-RAM)*

ISO/IEC 23912:2005, *Information technology — 80 mm (1,46 Gbytes per side) and 120 mm (4,70 Gbytes per side) DVD Recordable Disk (DVD-R)*

ISO/IEC 25434:2007, *Information technology — Data interchange on 120 mm and 80 mm optical disk using +R DL format — Capacity: 8,55 Gbytes and 2,66 Gbytes per side (recording speed up to 8x)*

ISO/IEC 26925:2006, *Information technology — Digital storage media for information interchange — Data Interchange on 120 mm and 80 mm Optical Disk using +RW HS Format — Capacity: 4,7 Gbytes and 1,46 Gbytes per Side (Recording speed 8X)*

ISO/IEC 29642:2007, *Information technology — Data Interchange on 120 mm and 80 mm optical disk using +RW DL format – Capacity: 8,55 Gbytes and 2,66 Gbytes per side (recording speed 2,4x)*

4 Terms and definitions

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

4.1 archival

ability of a medium or system to maintain the retrievability of recorded information for a specified extended period of years

4.2 Arrhenius method

accelerated aging model based on the effects of temperature

4.3 baseline

initial test analysis measurements (e.g. initial error rate) after recording and before exposure to a stress condition; measurement at stress time $t=0$ hours

4.4**bootstrap method**

statistical method for estimating the sampling distribution by re-sampling with replacement from the original sample

NOTE See Annex E.

4.5**Eyring Method**

accelerated aging model based on the effects of temperature and relative humidity

4.6**error rate**

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

4.7**incubation**

process of enclosing and maintaining controlled test sample environments

4.8**life expectancy****LE**

length of time estimation that information is predicted to be retrievable in a system while in a specified environmental condition

4.9**maximum error rate**

maximum of the error rate measured anywhere in one of the relevant areas on the disk

NOTE 1 For DVD-R/RW and +R/+RW this is the Maximum PI Sum 8.

NOTE 2 For DVD-RAM this is the Maximum BER.

4.10**retrievability**

ability to recover physical information as recorded

4.11**stress**

temperature and relative humidity variables to which the sample is exposed for the duration of test incubation intervals

4.12**system**

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

4.13**uncorrectable error**

error in the playback data that was not corrected by the error correcting decoders

NOTE For DVD-R/RW, +R/+RW, and DVD-RAM, this is an error that is uncorrected by the Reed-Solomon product code defined in ISO/IEC 16448 for DVD ROM systems.

5 Conventions and notations

5.1 Representation of numbers

A measured value is rounded off to the least significant digit of the corresponding specified value. For instance, it implies that a specified value of 1,26 with a positive tolerance of + 0,01 and a negative tolerance of - 0,02 allows a range of measured values from 1,235 to 1,275.

5.2 Names

The names of entities, e.g. specific tracks, fields, zones, etc. are given a capital initial.

6 List of acronyms

BER	byte error rate
LCL	lower confidence limit
LE	life expectancy
PI	parity (of the) inner (code)

7 Measurements

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7.1 Summary

7.1.1 Stress Incubation and Measuring

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A sampling of disks will be measured at 4 stress conditions plus a control disk at room ambient condition. A minimum number of 20 disks will be included as a group for each stress condition as shown in Table 2.

Each stress condition's total time will be divided into interval time periods. Each disk in each group of disks will have their initial error rates measured before their exposure to stress conditions. Thereafter, each disk will be measured for their error rates after each stress condition incubation time interval. The control disk will also be measured following each incubation time interval.

7.1.2 Assumptions

This Standard makes the following assumptions for applicability of media to be tested:

- specimen life distribution is appropriately modelled by a statistical distribution,
- the Eyring model can be used to model acceleration with the two stresses involved (temperature and relative humidity),
- the dominant failure mechanism acting at the usage condition is the same as that at the accelerated conditions,
- the compatibility of the disk and drive combination will affect the disk's initial recording quality and the resulting archival test outcome,
- a hardware and software system needed to read the disk will be available at the time the retrievability of the information is attempted,
- the recorded format will be recognizable and interpretable by reading software.

7.1.3 Error Rate

Of all specimen media the Error rate shall be measured in the disk testing locations as defined in 6.5. For each sample the Maximum error rate shall be determined.

Each DVD-R/RW, +R/+RW disk will have their maximum PI Sum 8 (Max PI-8) determined.

Each DVD-RAM disk will have its maximum byte error rate (Max BER) determined.

Other disk formats not referenced in this document will have the maximum of their defined error rates determined.

Data collected at each time interval for each individual disk are then used to determine the estimated lifetime for that disk at that stress condition.

7.1.3.1 PI Sum 8

Per ISO/IEC 16448:2002, a row in an ECC block that has at least 1 byte in error constitutes a PI error. PI Sum 8 is measured over 8 ECC blocks. In any 8 consecutive ECC blocks the total number of PI errors, also called PI Sum 8, before error correction shall not exceed 280.

7.1.3.2 BER

The number of erroneous symbols shall be measured at any consecutive 32 ECC blocks in the first pass of the decoder before correction. The BER is the number of erroneous symbols divided by the total number of symbols included in the 32 consecutive ECC blocks. The maximum value of the BER measured over the area specified in 6.5 shall not exceed 10^{-3} . (See Annex F).

7.1.4 Data Quality

Data quality is checked by plotting the median rank of the estimated time to failure values with a best fit line for each stress condition. The lines are then checked for reasonable parallelism.

7.1.5 Regression

The time-to-failure values at each stress condition are then regressed to find a histogram of the time-to-failure values at ambient condition using the bootstrap method.

The mean lifetimes are regressed against temperature and relative humidity according to an Eyring acceleration model.

7.2 Test specimen

The disk sample set shall represent the construction, materials, manufacturing process, quality and variation of the final process output.

Consideration shall be made to shelf life. Disks with longer shelf time before recording and testing may impact test results. Shelf time shall be representative of normal usage shelf time.

7.3 Recording conditions

Before entering media into accelerated aging tests, they shall be recorded as optimally as is practicable, according to the descriptions given in the related standard. OPC (optimum power control) during writing process shall serve as the method to achieve recorded media minimum error rates. It is generally understood that optimally recorded media will yield the longest predicted life results. Media is deemed acceptable for entry into the aging tests when its error rate and all other media parametric specifications are found to be within its respective standard's specification limits.

Recording hardware is at the discretion of the recording party. It may be either commercial drive-based or specialty recording tester based. It shall be capable of producing recordings that meet all specifications.

The maximum recording speed shall be at the media's highest rated speed and this speed shall be reported.

7.3.1 Recording test environment

When performing the recordings, the air immediately surrounding the media shall have the following properties:

- temperature: 23 °C to 35 °C
- relative humidity: 45 % to 55 %
- atmospheric pressure: 60 kPa to 106 kPa

No condensation on the disk shall occur. Before testing the disk shall be conditioned in this environment for 48 h minimum. It is recommended that before testing the entrance surface is cleaned according to the instructions of the manufacturer of the disk.

7.3.2 Recording method

Specimen disks shall be recorded at a single session and finalized.

7.4 Playback conditions iTeh STANDARD PREVIEW
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7.4.1 Playback tester

All media shall be read by the playback tester as specified in each of the medium's standard and at their specified test conditions. <https://standards.iteh.ai/catalog/standards/sist/43492b4f-283a-40d0-bc29-c8e8eabeb6d5/iso-iec-10995-2008>

Specimen media shall be read as described in the format standards identified in Clause 3.

7.4.2 Playback test environment

When measuring the error rates, the air immediately surrounding the disk shall have the following properties:

- temperature: 23 °C to 35 °C
- relative humidity: 45 % to 55 %
- atmospheric pressure: 60 kPa to 106 kPa

Unless otherwise stated, all tests and measurements shall be made in this test environment.

7.4.3 Calibration

The test equipment shall be calibrated as prescribed by its manufacturer using calibration disks approved by said manufacturer and as needed before disk testing.

A control disk shall be maintained at ambient conditions and its error rate measured at the same time the stressed disks are measured initially and after each stress interval.

The mean and standard deviation of the control disk shall be established by collecting at least five measurements. Should any individual error rate reading differ from the mean by more than three times the standard deviation, the problem shall be corrected and all data collected since the last valid control point shall be re-measured.

7.5 Disk testing locations

Testing locations shall be a minimum of three bands spaced evenly from inner, middle and outer radius locations on the disk as indicated in Table 1. The total testing area shall represent a minimum of 5 % of the disk. Each of the three test bands shall have more than 750(2EEh) ECC Blocks for 80 mm disks, and 2 400(960h) ECC Blocks for 120 mm disks.

Table 1 - Nominal radii of the three test bands

	DVD-R/RW, +R/+RW disk (Single Layer / Dual Layer)		DVD-RAM disk	
	80 mm	120 mm	80 mm	120 mm
Band 1	25,0	25,0	24,1-25,0	24,1-25,0
Band 2	30,0	40,0	29,8-30,8	39,4-40,4
Band 3	35,0	55,0	34,6-35,6	54,9-55,8

8 Accelerated stress test

8.1 General

Information properly recorded on an archival quality optical disk should have a life expectancy exceeding a predetermined number of years. Accelerated aging studies are used in order to conclude that a life expectancy exceeds the predetermined minimum number of years. This test plan is intended to provide the information necessary to satisfactorily evaluate the particular optical disk system including proposed archival quality optical disks.

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8.2 Stress conditions

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8.2.1 General

Stress conditions for this test method are increases in temperature and relative humidity. The stress conditions are used to accelerate the chemical reaction rate from what would occur normally at ambient or usage conditions. The chemical reaction is considered degradation in desired material property that eventually leads to disk failure.

Four stress conditions and the minimum number of specimens for those stress conditions that shall be used are shown in Table 2. Additional specimens and conditions may be used if desired for improved precision.

The total time for each stress condition as given in Table 2 is divided into four equal incubation durations. The temperature and relative humidity during each incubation cycle shall be controlled as depicted in Table 3 and Figure 1. After each cycle of incubation all specimens shall be measured.

Table 2 - Stress conditions for use with the Eyring Method

Test cell number	Test stress condition (inc)		Number of specimens	Incubation duration hours	Total time hours	Intermediate RH %RH	Min equilibration duration hours
	Temp (°C)	%RH					
1a	85	85	20	250	1 000	30	7
2a	85	70	20	250	1 000	30	6
3a	65	85	20	500	2 000	35	9
4a	70	75	30	625	2 500	33	11