BS ISO 18927:2013

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Imaging materials — Recordable compact disc systems — Method for estimating the life expectancy based on the effects of temperature and relative humidity

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National foreword

This British Standard is the UK implementation of ISO 18927:2013. It supersedes BS ISO 18927:2008 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CPW/42, Photography.

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INTERNATIONAL STANDARD

ISO 18927

Third edition
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Imaging materials — Recordable compact disc systems — Method for estimating the life expectancy based on the effects of temperature and relative humidity

Matériaux pour image — Systèmes de CD enregistrables — Méthode d'estimation de l'espérance de vie basée sur les effets de la température et de l'humidité relative

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member 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 shall not be held responsible for identifying any or all such patent rights.

ISO 18927 was prepared by Technical Committee ISO/TC 42, *Photography*.

This third edition cancels and replaces the second edition (ISO 18927:2008), of which it constitutes a minor revision.

The following change has been made to the second edition:

— An update of the bibliographical references.

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INTERNATIONAL STANDARD ISO 18927:2013(E)

Imaging materials — Recordable compact disc systems — Method for estimating the life expectancy based on the effects of temperature and relative humidity

1 Scope

This International Standard specifies a test method for estimating the life expectancy of information stored on recordable compact disc systems. Only the effects of temperature and relative humidity on the media are considered.

This International Standard does not cover the effects of light, air pollution, or time-dependent flow phenomena.

2 Normative references

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

ISO/IEC 10149[1)], *Information technology — Data interchange on read-only 120 mm optical data disks* (CD-ROM)

IEC 60908, *Audio recording — Compact disc digital audio system*

Experimental statistics, U.S. National Bureau of Standards Handbook 91, 1963

3 Terms and definitions

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

3.1
baseline
condition representing the disc at time of manufacture

Note 1 to entry: This is customarily the initial parameter measurement taken prior to any application of stress. The designation is usually $t = 0$ for a stress time equal to zero hours.

3.2
block error rate
BLER
ratio of erroneous blocks to total blocks measured at the input of the first (C1) decoder (before any error correction is applied)

Note 1 to entry: The more commonly reported value for BLER is the number of erroneous blocks per second measured at the input of the C1-decoder during playback at the standard (1X) data rate.

[IEC 60908]

3.2.1
maximum block error rate
max BLER
maximum BLER measured anywhere on a disc

1) Equivalent to ECMA 130.

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3.3
compact disc-recordable
CD-R
recordable optical disc in which information can be recorded to certain areas in compact disc format

Note 1 to entry: Information can be recorded once and read many times.

Note 2 to entry: The term "compact disc-write once" (CD-WO) has also been used to describe this type of disc.

3.4
cumulative distribution function
$F(t)$
probability that a random unit drawn from the population fails by time t, or the fraction of all units in the population which fails by time t

3.4.1
lognormal cumulative distribution function
$F(t)$
cumulative distribution function in which the logarithm of the relevant parameter, in this International Standard the disc lifetime, has a normal distribution and is defined by the following equation:

$$F(t)=\frac{1}{\sqrt{2\pi}}\int_0^t \frac{1}{\sigma_l x} e^{-\frac{1}{2}\left(\frac{\ln(x)-\mu_l}{\sigma_l}\right)^2} dx$$

where

t	is the time;
x	is a variable representing disc lifetime;
σ_l	is the log standard deviation;
μ_l	is the log mean;
$\ln(x)$	is the natural logarithm of x

Note 1 to entry: When $t = e^{\mu_1}$, the lognormal cumulative distribution function evaluates to 0,5. In other words, the model predicts that half the samples have failed at that time.

3.5
disc-at-once recording
method of recording a CD-R disc whereby the entire CD is recorded in one pass without turning off the laser

3.6
end-of-life
occurrence of any loss of information

3.7
extended-term storage conditions
storage conditions suitable for the preservation of recorded information having permanent value

3.8
glass transition
reversible change in an amorphous polymer from, or to, a viscous or rubber condition to, or from, a hard and relatively brittle one

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3.8.1
glass transition temperature
T_g
approximate mid-point of the temperature range over which glass transition takes place

Note 1 to entry: T_g can be determined readily only by observing the temperature at which a significant change takes place in a specific electrical, mechanical, or other physical property.

Note 2 to entry: T_g can also be sensitive to the moisture content of the polymer.

3.9
information
signal or image recorded using the system

3.10
life expectancy
LE
length of time that information is predicted to be acceptable in a system after dark storage at 23 °C and 50 % relative humidity (RH)

3.10.1
standardized life expectancy
SLE
minimum life span, predicted with 95 % confidence, of 95 % of the product stored at a temperature not exceeding 25 °C and a relative humidity (RH) not exceeding 50 % RH

3.11
retrievability
ability to access information as recorded

3.12
stress
experimental variable to which the specimen is exposed for the duration of the test interval

Note 1 to entry: In this International Standard, the stress variables are confined to temperature and relative humidity.

3.13
survivor function
$R(t)$
probability that a random unit drawn from the population survives at least time t, or the fraction of all units in the population which survive at least time t

Note 1 to entry: $R(t) = 1 - F(t)$.

3.14
system
combination of material, hardware, software, and documentation necessary for recording and/or retrieving information

3.15
test cell
device that controls the stress to which the specimen is exposed

3.16
track-at-once recording
method of recording a CD-R disc whereby each track is recorded individually with 150 empty sectors immediately preceding it and two run-out sectors immediately following

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3.17
uncorrectable error
error in the playback data that is not correctable by the cross interleave Reed-Solomon code defined in IEC 60908 as implemented in a system

4 Purpose and assumptions

4.1 Purpose

The purpose of this International Standard is to establish a methodology for estimating the life expectancy of information stored on recordable compact disc systems. This methodology provides a technically and statistically sound procedure for obtaining and evaluating accelerated test data.

The methodology deals only with the effects of temperature and humidity on the retrievability of stored information. For this reason, this International Standard is primarily directed to those storage applications, e.g. libraries and archives, in which exposure to other influences potentially detrimental to information life expectancy, such as chemical agents, intense light sources, and improper handling, is controlled and minimized.

4.2 Assumptions

The validity of the procedure defined by this International Standard relies on three assumptions:

— specimen life distribution is appropriately modelled by the lognormal distribution;

— the kinetics of the dominant failure mechanism is appropriately modelled by an Eyring acceleration model;

— the dominant failure mechanism acting at the usage condition is the same as that at the accelerated conditions.

Publications by Hamada and Stinson provide data indicating that these assumptions are applicable to compact disc-recordable (CD-R) systems (see references[5] and[6] in the Bibliography).

5 Measurements

5.1 Summary

A sampling of 80 recorded discs shall be divided into five groups according to a specified plan. Each group of discs (test cell) shall be subjected to one of five test stresses, combinations of temperature and relative humidity. Periodically during the stress conditions, all discs from each stress group shall have their block error rate (BLER) measured. Data collected at each time interval for each individual disc are then used to determine a lifetime for that disc.

The disc lifetimes at each stress level are fitted to a lognormal distribution to determine a mean lifetime for the stress. The resulting five mean lifetimes are regressed against temperature and relative humidity according to an Eyring acceleration model. This model is then used to estimate the distribution of lifetimes at a usage condition.

5.2 Block error rate (BLER)

End-of-life is the occurrence of any loss of information. Ideally, each specimen is tested until the first loss of information occurs. Realistically, this is impractical. This International Standard considers max BLER to be a high-level estimate of the performance of the system. The objective of measuring BLER is to establish a practical estimation of the system's ability to read recorded data without uncorrectable errors. A change in max BLER in response to the time at an accelerated temperature and humidity is the principal quality parameter.

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IEC 60908 states that the BLER averaged over any 10 s shall be less than 3×10^{-2}. At the standard (1X) data rate, the total number of blocks per second entering the C1-decoder is 7 350. Thus, an equivalent limit on BLER is 220 blocks per second.

A BLER of 220 is an arbitrary level chosen as a predictor of the onset of uncorrectable errors and thereby end-of-life. A BLER of 220 corresponds to an upper limit for error correction. As a result, lower BLER discs are recommended to use for long-term storage.

5.3 Test equipment

5.3.1 General requirements

A compact disc player that conforms to ISO/IEC 10149 and software capable of producing a display of max BLER.

If it becomes necessary to replace the test equipment, the US National Bureau of Standards Handbook 91 shall be followed for correlating test equipment outputs.

The make, model, and version of the test equipment (including software) shall be reported with the test results.

5.3.2 Calibration and repeatability

Calibration according to the tester manufacturer's procedure shall be performed prior to any measurement data being collected. A calibration disc shall be available from an accredited source.

In addition to the calibration disc, one control disc shall be maintained at ambient conditions and its max BLER measured before and after each data collection interval. A control chart shall be maintained for this control disc.

The mean and standard deviation of the control disc shall be established by collecting at least five measurements. Should any individual max BLER 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.

5.4 Test specimen

5.4.1 General requirements

A test specimen is any disc that, after recording, meets ISO/IEC 10149 specifications and contains representative data extending to within 2 mm of the maximum recording diameter.

5.4.2 Specimen selection

All discs shall be nominally identical with regard to substrate groove structure, layer structure, coating composition, recording capacity, and age prior to test initiation. It is preferred that the CD-R media be chosen from different lots and production lines in order to be representative of normal process variations.

All discs shall be maintained in the manufacturer's transportation and storage conditions prior to recording.

The nominal disc capacity shall be reported with the test results.

5.4.3 Recording system

Specimen discs may be recorded in any appropriate recording device. Since the extrapolated lifetime is a function of the system including the CD-R media, all discs shall be recorded identically to the extent possible. Similar recording devices shall be used, as well as similar software and recording conditions. Discs recorded on different physical devices shall be distributed as equally as possible across the test cells.

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