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Imaging materials — Optical disc media — Storage practices

Matériaux pour l'image — Milieux pour disque optique — Pratiques de stockage

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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 18925 was prepared by Technical Committee ISO/TC 42, *Photography*.

This third edition cancels and replaces the second edition (ISO 18925:2008), 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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Introduction

Use of optical disc material is becoming widespread in audio, video, and computer applications. Preservation of this information is becoming of increasing concern to society, particularly as the recorded information becomes older and frequently of greater value to libraries, archives, museums, government agencies, and commercial organizations.

The stability of optical discs is dependent upon that of the complete system. This includes the stability of the material itself, the equipment on which it is run and, in systems, upon the necessary software. ISO 18921 specifies a methodology for estimating the life expectancy of the CD-ROM. Other optical discs will be addressed in future International Standards. These standards consider only the effects of temperature and humidity and do not include other factors such as light, corrosive gases, and particulates. International Standards are not available on the life expectancy of hardware and the problems associated with hardware wearing out or becoming obsolete.

It is advisable that optical disc users store discs under conditions that will extend their life and handle the material so that it will not be subjected to stress and undergo physical breakdown during use. This International Standard addresses the concerns of long-term storage.

A major component of a large number of optical discs is the polycarbonate substrate. Polycarbonate is a very durable material, but it does absorb moisture and there is always an equilibrium between the ambient humidity and the moisture content of the disc. Polycarbonate is susceptible to decomposition under certain conditions and given a suitable catalyst.

The second component of most optical discs is the reflective layer. This layer is usually some highly reflective metal such as aluminium, silver, or gold. Each of these materials is subject to reaction with various chemicals that can be found in the environment. Aluminium, for example, combines readily with oxygen to form aluminium oxide. Silver combines with sulfur to tarnish and form silver sulfides. Gold is known to react with chlorine to form gold chlorides.

A third component of these discs is some type of seal coat. This is typically a UV-cured polymer whose purpose is to protect the reflective layer and any other material layers in the disc.

A fourth component, in the case of some recordable optical discs, is the dye layer. For magneto-optic or phase change discs, additional layers are also included.

Regardless of the inherent stability of the various disc layers, it is known that good storage conditions will extend the life of all optical discs. While a good storage environment cannot reverse any degradation that has already occurred, it can slow down additional deterioration.

A single storage condition is described in this International Standard. This condition is intended for discs that contain recorded information of long-term value. Various manufacturers' studies indicate that the life expectancy of well-manufactured optical discs is in excess of 50 years under typical room ambient conditions (see References [1] and[2]).

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Imaging materials — Optical disc media — Storage practices

1 Scope

This International Standard establishes extended-term storage conditions for optical discs and provides recommendations concerning the storage conditions, storage facilities, enclosures, and inspection for optical discs. It is applicable to discs made for audio, video, instrumentation, and computer use.

Recommendations are general in nature and it is advisable that the manufacturer's cautions for specific material be considered. Relaxation from these recommendations, whether before or after recording, will generally result in shortened life expectancy.

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 15486, *Information technology — Data interchange on 130 mm optical disk cartridges of type WORM (Write Once Read Many) using irreversible effects — Capacity: 2,6 Gbytes per cartridge*

NFPA 75, *Standard for the Protection of Electronic Computer/Data Processing Equipment*

3 Terms and definitions

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

3.1
blister
localized delamination that looks like a bubble

3.2
compact disc
CD
optical disc format in which the information layer is located at one surface of a substrate and the data can be read by an optical beam

Note 1 to entry: CD is the subject of IEC 60908.

3.2.1
compact disc-recordable
CD-R
recordable optical disc in which information can be recorded to certain areas in the compact disc format

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

3.2.2
compact disc read-only memory
CD-ROM
optical disc to which information is transferred during manufacture to certain areas in the compact disc format

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

Note 2 to entry: CD-ROM is the subject of ISO/IEC 10149.

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3.2.3
compact disc-rewritable
CD-RW
recordable optical disc in which information can be recorded to certain areas in the compact disc format

Note 1 to entry: Information can be erased and new information recorded many times and read many times.

3.3
container
box, can, or carton used for storage and shipping of recording materials

3.4
digital versatile disc
DVD
digital video disc (deprecated)
optical disc format in which one or more information layers are located between two substrates and the data can be read by an optical beam

3.5
delamination
separation of a laminate into its constituent layers

3.6
dew point
temperature at which moisture begins to condense on a surface

Note 1 to entry: See *relative humidity* (3.16).

EXAMPLE The more humid the air, the higher the dew point temperature.

3.7
enclosure
folder, envelope, sleeve, or clam shell intended for physical protection against mechanical damage

3.8
extended-term storage conditions
storage conditions suitable for the preservation of recorded information having permanent value

3.9
fire-protective storage
facilities designed to protect records against excessive temperatures, water and other fire-fighting agents, and steam developed by insulation of safes or caused by the extinguishing of fires and collapsing structures

3.10
insulated record container
storage box designed to withstand elevated temperatures and conforming to national standards and regulations

3.11
isoperm lines
lines of constant life plotted as a function of temperature and relative humidity

3.12
life expectancy
LE
length of time that information is predicted to be retrieved in a system at 23 °C and 50 % relative humidity (RH)

3.13
magnetic field intensity
level of the magnetic field at a point in space

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3.14
medium
material on which the information is recorded

3.15
MO disc
optical disc in which the information is recorded using magneto-optical technology in some specified format

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

3.16
relative humidity
RH
ratio, defined as a percentage, of the existing partial vapour pressure of water to the vapour pressure at saturation

Note 1 to entry: It is usually, but not always, equal to the percentage of the amount of moisture in the air to that at saturation.

3.17
storage environment
conditions for storing materials, i.e. temperature, relative humidity, cleanliness of facilities, and atmospheric pollutants

3.18
storage housing
physical structure supporting materials and their enclosures

Note 1 to entry: It can consist of drawers, racks, shelves, or cabinets.

3.19
system
combination of material, hardware, software, and documentation necessary for recording and/or retrieving information

3.20
WORM disc
optical disc in which the data in specified areas can be written only once and read multiple times by an optical beam

4 Environmental conditions

4.1 Humidity and temperature limits

The average relative humidity of an extended-term storage environment shall be maintained between 20 % RH and 50 % RH. Cycling of relative humidity shall not be greater than ± 10 %. Ideally, the maximum temperature for extended periods should not exceed 25 °C, and a temperature below 23 °C is preferable. The peak temperature shall not exceed 32 °C. Generally, useful life will be increased by storing discs at low temperature and low relative humidity since chemical degradation is reduced at these conditions (see Annex A). Storage of discs below −10 °C and below 10 % RH is not recommended.

Specific manufacturer's recommendations, when available, should take precedence over the above general recommendations.

For any facility, it is impossible to specify what the best relative humidity and storage temperature should be, since it depends upon the value of the material, the past storage history, the length of time the disc is to be kept, the size of the vault, the cost of various options, and the climate conditions where the facility is located.

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Lower temperatures within the specified relative humidity range can be difficult to achieve with normal humidity air-conditioning equipment and may require a specialized installation. Automatic control systems are recommended, and they shall be checked frequently enough to determine that the specified temperature and humidity limits are not being exceeded. A reliable hygrometer can be used for humidity measurements.

Where air conditioning is not practical, high humidities may be lowered by electrical refrigeration-type dehumidifiers controlled with a hygrostat. Inert desiccants, such as chemically pure silica gel, may be used, provided the dehumidifier is equipped with filters capable of removing dust particles down to 0,3 µm in size and is controlled to maintain the relative humidity within the specified range. Dehumidification may be required in storage areas such as basements and caves which have inherently low temperatures but which frequently exceed the upper humidity limit.

The recommended humidity and temperature conditions can be maintained either within individual storage housings or within storage rooms containing such housings.

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4.2 Contaminants and gaseous impurities

Contaminants can pass through very small cracks or scratches in protective layers, react with reflective or recording layers in the disc, and potentially cause loss of data. Best available technologies shall be used to ensure minimization of gaseous impurities such as ammonia, chlorine, sulfides, peroxides, ozone, oxides of nitrogen, smoke, and acidic gases. Molecular sieves may be included in storage environments to absorb pollutants and excess humidity. Manufacturers should be consulted for information on maximum acceptable levels of airborne contaminants.

Water shall not be allowed to collect on plastic surfaces. Oil from fingerprints or organic vapours in the environment can migrate through the disc, resulting in long-term degradation.

4.3 Magnetic fields

Magnetic fields are a concern only for magneto-optical discs. The optical disc cartridge standard (see ANSI INCITS 212) for magneto-optical discs, for example, specifies maximum field strength at the recording layer of 48 000 A/m (600 oersteds) as a storage condition. The fields specified for magneto-optic discs are higher than for magnetic tape (see ISO 18923) because the optical material must be heated above the Curie temperature by the laser in the presence of this field for recording to occur.

External magnetic fields are most frequently observed near motors and transformers, e.g. commercial building elevator installations. Most of such installations are localized and the field intensity falls off rapidly with separation. A separation of a few metres from the source will usually provide sufficient protection. External fields of a more unanticipated nature may be produced by some headphones and microphones or by cabinet latches.

5 Materials

The materials used for storage housings and enclosures shall be chemically stable and non-debris producing. They shall be free from distortion (warpage).

6 Enclosures

6.1 General requirements

Enclosures shall be resistant to impact moisture and dust intrusion. Enclosures made of paper or cardboard shall not be used. They shall be designed in such a way that neither the disc data nor the label surface is in contact with the enclosure when the enclosure is stored in its proper vertical position. Enclosures shall not be able to be deformed or mechanically compromised in the defined storage conditions. An enclosure lid shall be capable of being latched, attached, or locked to prevent accidental opening.

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Polystyrene, polypropylene, and polycarbonate are suitable plastics for storage enclosures. However, prolonged exposure to strong light, including fluorescent and incandescent lighting, causes yellowing of polystyrene plastics, sometimes accompanied by crazing. Exposure to radiation rich in ultraviolet (UV), such as direct sunlight, is even more harmful and results in physical breakdown of polystyrene and polypropylene (see Reference [3]).

Foam rubber and plastics such as cellulosics, polyvinyl chloride (PVC), and highly plasticized materials shall be avoided.

6.2 Labelling

Enclosures shall provide a means for labelling that allows identification of the recorded information contained within. The labelling shall be non-acid, non-debris, and non-oxidant producing, and shall be attached or affixed on the outside of the enclosure in such a manner that it will remain for the life expectancy of the discs. Multiple labels should be kept to a minimum to avoid the possibility of adhesive migration.

"Stick-on" labels shall not be applied to the disc for extended-term storage. These labels may cause mechanical imbalance of the disc and mechanical deformation. When "stick-on" labels are misapplied, any effort to remove or reposition the label may damage the disc. Furthermore, it is possible that chemical reactions may occur between the label components and the disc surface.

Other marking systems have their own unique problems. The disc manufacturer should be consulted when selecting marker systems. Some solvents in the ink-based systems may damage the disc. Sharp writing instruments can easily damage the disc. Thermal printing techniques have been known to damage the information on the disc if the applied thermal energy is too great. The disc manufacturer should be consulted prior to the use of thermal printing on any specific disc surface.

7 Preparation

7.1 General

All preparation of media for storage shall be done in areas that comply with the requirements set forth in Clause 4.

7.2 Acclimatization

In order to minimize stress in the material and reduce the chance of moisture condensation, materials shall be acclimatized for at least 24 h at ambient room conditions when being transferred from outside the storage facility or when being removed from a storage area to an access or production area. A maximum rate of change of 10 °C in any one hour and 10 % RH in any one hour is recommended. This rate of change shall be slow enough to avoid condensation.

Materials shall be kept in tight storage containers during acclimatization to minimize the temperature and humidity gradients that occur. When materials are stored at low temperatures, they shall be allowed to warm up to a temperature above the dew point prior to removal from the container in order to avoid moisture condensation.

If possible, when transferring optical discs to a lower temperature environment, the humidity should be acclimatized first, then the temperature. When transferring optical discs to a higher temperature environment, the temperature shall be acclimatized first, then the humidity (see Annex B).

8 Storage housing

Drawers, racks, and shelves shall be designed in such a way that the discs in their containers can be placed in their appropriate vertical position. They shall be designed and utilized so that containers do not support other containers.

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Shelving shall be strong enough to support the shape and weights of the containers without deformation of the container or the shelving itself. Shelves should allow for adequate airflow so that the conditioned environment can be maintained throughout the storage area. To avoid catastrophic damage, shelves shall not be placed too close to heat sources, water pipes, or sprinkler heads. Shelves should possess a lip to minimize dripping of melted plastic and burning plastic onto lower shelves in case of fire.

9 Storage rooms

Storage rooms shall be designed to be able to bear the load of fully loaded shelving. They shall be clean areas, satisfying at least Class 100 000 cleanroom requirements (see ISO/IEC 15486:1998, Annex A), and be under constant environmental control in accordance with the specifications of Clause 4. Air pressure in the storage area shall be maintained at a positive pressure relative to adjacent hallways and rooms.

Dust- and/or debris-generating devices or materials shall not be allowed in the storage room, e.g. carpet, draperies, unsealed insulation, fibrous wall coverings and furnishings. Storage rooms shall not be used to acclimatize or pack incoming/outgoing materials (see NFPA 75).

In order to minimize UV damage to labelling, packaging materials, and possibly to the materials themselves, rooms shall not be lit other than when being actively accessed. If this is not possible, storage housing which can practically cut off the light exposure shall be used. Some dye-based discs are particularly susceptible to damage from exposure to UV light. In such situations, install UV filter sleeves over the fluorescent light tubes.

Walls and enclosures of environmentally controlled spaces shall be designed to prevent condensation of moisture on interior surfaces. Provisions shall be made to prevent damage from water, i.e. floods, leaks, sprinklers, etc. Floors shall be provided with drains, incorporating reverse flow devices to inhibit insects and wastewater back flow, or some other means of water removal. Storage rooms should be located above basement levels where possible.

Storage rooms should be periodically cleaned. A goal shall be the removal of dust without blowing fine particles around and the removal of dirt without the use of acids or oxidants. Dust removal shall be done by a vacuum system that has an exhaust pipe that carries the dust completely out of the storage room. An alternative method is to use a cleanroom vacuum cleaner with special multistage filters, including a final 99,97 % HEPA exhaust filter capable of removing particles of 0,3 μm or larger.

Non-chemically treated, clean, and static-free wipes shall be used to remove dirt and dust from shelves and from the outside surfaces of containers. Chemical cleaning solutions shall not be used to clean floors or any other surfaces within the storage facility; this includes all common household cleaners. A minimum amount of water shall be used with a clean mop to clean floors. All traces of water shall be removed immediately by a clean dry-mop.

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10 Fire-protective storage

Enclosure materials for fire-resistant storage shall be sufficiently fire-resistant that after heating for 4 h at 150 °C they will not ignite or release more reactive fumes than the optical discs themselves.

For protection against fire and associated hazards, the disc package shall be placed in either fire-resistive vaults or “insulated record containers”. If fire-resistive vaults are used, they shall be constructed in accordance with recommendations contained in appropriate standards and regulations (see NFPA 232 and Japanese Ordinance No. 306), with particular care for protection from steam. Masonry or concrete walls may release steam from internally bonded water when heated in a fire. A vapour barrier is recommended for such vaults; otherwise, sealed containers shall be used.

“Insulated record containers” conforming to appropriate national standards and regulations may be used, such as Class 150 record containers in UL 72 and JIS S 1037. They shall not exceed an interior temperature of 65 °C and an interior relative humidity of 85 % when given a fire exposure test from 1 h to 4 h depending on the classification of the record container.

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For the best protection of the information from fires, duplicate copies of discs shall be placed in other storage areas, preferably in different buildings located some distance away from each other.

11 Identification, inspection, and cleaning

11.1 Identification

Records containing the proper date, control-number information, location, title, and other required information shall be maintained.

11.2 Inspection

Representative samples of discs shall be inspected at five-year intervals beginning with an initial inspection at acquisition. If deviations from the recommended temperature and relative humidity ranges have occurred, inspection shall be made at more frequent intervals. A sampling plan established in advance shall be used, and a different lot shall be inspected each time. Deterioration of either discs or enclosures shall be noted. Discs shall be examined for playback performance, physical distortion, debris, and container and label deterioration.

Optical discs shall only be handled or touched using gloves. Dye-free gloves that do not shed, most commonly found as thin, clean, white lint-free cotton (or equivalent lint-free material) gloves shall be used.

If the material has been stored at a temperature below the dew point of the atmosphere where the inspection is to take place, the discs in their enclosures shall first be allowed to warm up to a temperature within a few degrees of that of the inspection room. The time required for warm-up increases with the volume of the material and the temperature difference.

Deterioration of either discs or enclosures shall be noted. Containers and labels shall be inspected for debris, deterioration, and legibility of information. Discs shall be visually inspected for debris, edge damage, and defects, such as delamination, blisters, discoloration, scratches, and pinholes. If the discs appear playable, they shall then be examined for playback performance, physical distortion, and disc unbalance. Appropriate measuring equipment should be used to objectively determine deterioration. Such equipment may be acquired or the user could use a service company to perform such evaluations.

Other than the need for cleaning, defects or deterioration noted during inspection shall trigger action to recover the data, correct the problem and eliminate the source.

11.3 Cleaning

If during inspection there is any evidence of dirt or debris on the media, discs shall be cleaned prior to putting them back into storage. Manufacturers' specific recommendations should be followed when cleaning the media.

As a general guide, only wiping with a soft, clean, lint-free cloth is recommended. Glass surfaces may be cleaned with an ammonia-based glass cleaner and a clean, non-abrasive cloth. The cleaning solution should be applied to the cloth and not to the disc.

The disc should be wiped in a radial direction to minimize the possibility of circumferential scratches. An alternative method of cleaning is to dust the disc with clean, purified, compressed air or nitrogen regulated to less than 275 kPa.

Scraping, burnishing procedures, and solvent cleaning should not generally be used.

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Annex A
(informative)

Temperature-relative humidity relationship

Degradation of optical disc material is caused by chemical reactions whose rates are generally lowered with decreasing temperature and decreasing relative humidity. Consequently, the useful life of optical discs can usually be increased by lowering the storage temperature and/or storage humidity.

A lower storage temperature can compensate for a higher humidity to obtain the same life expectancy. This relationship permits several temperature-relative humidity combinations to be acceptable for storage conditions, as shown in Figure A.1. The "isoperm lines" apply specifically to a Tellurium Selenium (TeSe) ablative type of WORM optical medium but should provide a general guideline for any similar type of optical material.

The term "median life" in Figure A.1 refers to the ability to read back data originally recorded on the disc based on the narrow-band signal-to-noise ratio (NBSNR). This relationship provides the storage vault designer some information to evaluate tradeoffs when selecting a reasonable design point.

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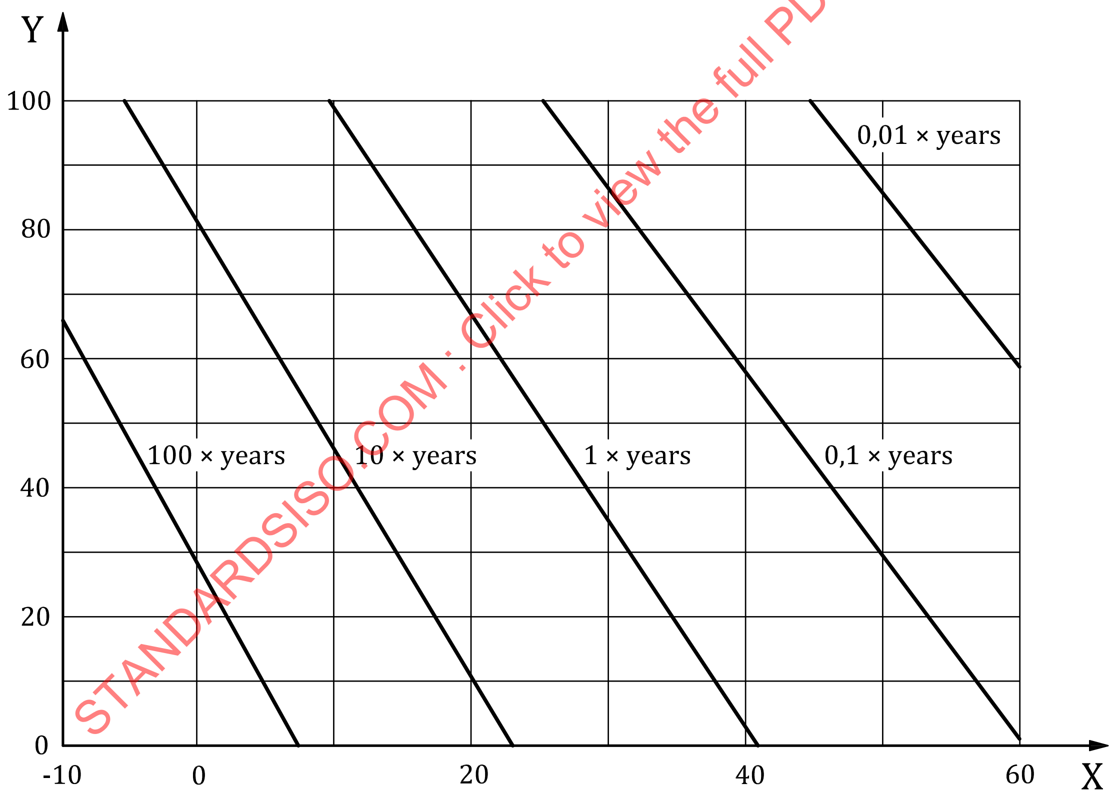

Key

X temperature, °C

Y relative humidity, %

NOTE Data are based on archive NBSNR at ID and high write power.

Figure A.1 — WORM median life, normalized to 25 °C and 50 % RH

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