SLOVENSKI STANDARD
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Ohranjanje kulturne dediščine - Smernice za načrtovanje vitrin za razstavljanje in hranjenje predmetov - 2. del: Tehnični vidiki

Conservation of cultural heritage - Guidelines for design of showcases for exhibition and preservation of objects - Part 2: Technical aspects

Erhaltung des kulturellen Erbes - Leitfaden für die Konstruktion von Schauvitrinen zur Ausstellung und Erhaltung von Objekten - Teil 2: Technische Aspekte

Conservation du patrimoine culturel - Lignes directrices pour la conception de vitrines destinées à exposer et préserver des biens culturels - Partie 2 : Aspects techniques

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97.195	Umetniški in obrtniški izdelki. Kulturne dobrine in kulturna dediščina	Items of art and handicrafts. Cultural property and heritage

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Conservation of cultural heritage - Guidelines for design of showcases for exhibition and preservation of objects - Part 2: Technical aspects

Conservation du patrimoine culturel - Lignes directrices pour la conception de vitrines destinées à exposer et préserver des biens culturels - Partie 2 : Aspects techniques

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 346.

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European foreword

This document (prEN 15999-2:2023) has been prepared by Technical Committee CEN/TC 346 “Conservation of cultural heritage”, the secretariat of which is held by UNI.

This document is currently submitted to the CEN Enquiry.

EN 15999 consists of the following parts, under the general title “Conservation of cultural heritage – Guidelines for showcases for exhibition and preservation of objects”:

— Part 1: General requirements,

— Part 2: Technical aspects.

Introduction

The main purpose of a showcase for cultural heritage objects on exhibition is to reduce the risks of total loss, physical damage, chemical and biological deterioration (e.g. by accidents, theft, vandalism, natural disasters, humidity, temperature, dust, pollutants, light, pests). A showcase adapted for its tasks is expected to have properties which have been selected and specified with regard to its specific use, requirements, value of object(s), and (projected) exhibition environment.

This document specifies how the performance of the showcase — as derived from needs identified during the risk assessment approach described in prEN 15999-1— can be technically specified by using classified properties. These classes characterize, determine or measure the performance of the showcase. The specification of the properties of a showcase can be used in the procurement phase or in the operating phase; e.g. to define showcase properties for objects on loan.

prEN 15999-2 is for stakeholders who are expected to understand the properties of a showcase, including end-users (such as collection managers, conservators, curators, registrars, installers, technical agents), designers (architects, persons in charge of scenography or museography), manufacturers, and contracting authorities who are in charge of the cultural institutions.

This document should facilitate both dialogue and collaboration between stakeholders who are engaged in projects which involve showcases. It provides technical information about conservation, safety and security, use and management of the showcase.

While recognizing that aesthetics of showcases are very important, the present document emphasizes functional design of the showcase, the practical needs of the user and the requirements of the objects for better preservation.

1 Scope

This document defines and classifies properties of passive showcases for the safe and secure display of cultural heritage objects for better preservation. It applies to most uses of the showcase: showcases for so called permanent or temporary exhibitions, historical or modular showcases, showcases in uncontrolled ambient environment, etc. Aspects of active showcases (those using electricity to directly condition their microclimates) and anoxic showcases (those containing inert atmospheres instead of air) are mentioned in this document, but their properties are not defined, nor classified.

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.

EN 1023-3:2000, *Office furniture - Screens - Part 3: Test methods*

EN 15898:2019, *Conservation of cultural heritage - Main general terms and definitions*

EN 1630:2021, *Pedestrian doorsets, windows, curtain walling, grilles and shutters - Burglar resistance - Test method for the determination of resistance to manual burglary attempts*

EN 410, *Glass in building - Determination of luminous and solar characteristics of glazing*

EN 50131 (all parts), *Alarm systems - Intrusion and hold-up systems*

EN 60529, *Degrees of protection provided by enclosures (IP Code)*

EN ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories* (ISO/IEC 17025:2017)

EN 60332-1-2:2004, *Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame (IEC 60332-1-2:2004)*

EN IEC 60332-3-24:2018, *Tests on electric and optical fibre cables under fire conditions - Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category C (IEC 60332-3-24:2018)*

ISO 20653:2013, *Road vehicles — Degrees of protection (IP code) — Protection of electrical equipment against foreign objects, water and access*

ISO 21348:2007, *Space environment (natural and artificial) — Process for determining solar irradiances*

prEN 15999-1: *Conservation of cultural heritage – Guidelines for design of showcases for exhibition and preservation of objects – Part 1: General instructions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 15898:2019 and in prEN 15999-1 and the following apply.

ISO and IEC maintain terminology 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
airtightness
capacity of an envelope to limit the entrance or escape of air or other gas

3.2
end-user
person with assigned responsibility for cultural heritage on display in showcases or for the showcases themselves

3.3
environment
physical, chemical and biological conditions surrounding the showcase

3.4
humidity buffering
smoothing of the peaks and troughs in relative humidity, whilst not changing the average relative humidity

3.5
humidity control
maintaining a relative humidity value different from the average relative humidity value of the environment (3.3)

3.6
pollution sorbent
material that captures some specific gaseous pollutants to reduce their concentration

3.7
relative humidity
ratio of the actual vapour pressure to the saturation vapour pressure

[SOURCE: EN 15757:2010, 3.9]

3.8
volatile organic compound
VOC
volatile organic compound, including VVOC (very volatile organic compound) and SVOC (semi volatile organic compound)

3.9
security personnel
those people in the organisation in the supply chain that have been assigned security related duties

Note 1 to entry: These people may or may not be employees of the organisation.

[SOURCE: ISO 28001:2007, 3.22]

4 Symbols and abbreviated terms

AER – air exchange rate,

RH – relative humidity (3.7),

T – temperature,

VOC – volatile organic compound (3.8),

UV – ultraviolet,

IR – infrared

5 Specification of properties of a showcase

5.1 Environmental factors

Showcases can enhance the physical protection of objects from environmental risks arising from incorrect humidity and temperature, pollutants, pests, UV and/or IR radiation.

5.1.1 Airtightness (3.1) and air exchange rate

The protective capacity of the showcase against the environmental factors listed below is mainly determined by its airtightness (3.1). This allows it to:

— limit entry of gaseous pollutants present in the showcase's environment (3.3) (e.g. external use of corrosive cleaning products, penetration of outdoor gaseous pollutants);

— reduce water vapour exchanges and improve microclimate control (e.g. moisture exchange due to low airtightness (3.1) limits the effectiveness and useful lifetimes of added moisture sorbent and decreases hygrometric control of buffering showcases, which rely on high loading of moisture sorbent in conjunction with higher airtightness (3.1));

— limit entry of particulate matter present in the room coming from indoor and outdoor sources (e.g. smoke, dust, sporae, pest eggs) that deposit on objects or infest them, and to decrease cleaning frequency of showcase interior.

When pollution comes from a source inside the showcase (e.g. an object releasing VOCs (3.8)), and objects made of vulnerable materials are present, higher airtightness (3.1) is unfavourable for object preservation. Intentional leaks (vents) should be created using natural or forced ventilation, or a material able to absorb and retain the pollution should be added.

Airtightness (3.1) of showcases generally decreases with time due to ageing and wear of sealing materials (e.g. joint adhesives, door-gaskets) and misalignment of the showcase with its openings (e.g. doors, technical compartments) and its joints due to deformation of glass and metal sheets.

Showcase airtightness (3.1) is quantifiable by the air exchange rate (AER). Categories of AER and showcase performance affected by the air exchange rate are indicated in Table 1. Different classes of AER are characterized by different levels of airtightness (3.1) from low airtightness (3.1) (AER ≥ 5 day^{-1}) to high airtightness (3.1) (AER < 0,4 day^{-1}).

Table 1 — Class labels according to AER with indicative capacity to maintain a suitable environment (3.3)

Class Label	AER [day^{-1}]	**Capacity to buffer against external (RH) fluctuation**	**Capacity to maintain internal hygrometric conditions (RH)**		**Capacity to provide protection against the ingress of pollutants** [b]	**Pollutant accumulation from off-gassing showcase materials and/or objects**
			Passive control	Active control		
AE 0	≥ 5,0	Can significantly reduce daily, but not weekly, fluctuations with very large amounts of moisture sorbent[a]; RH can be controlled with active systems	no	Yes with high capacity systems	Slight. Some protection offered against external pollution, but not recommended.	Least build-up
AE 1	< 5,0 to 3,0	Can significantly reduce weekly, but not monthly, fluctuations with large amounts of moisture sorbent[a]; RH can be controlled with active systems	will struggle to control RH depending on room environment (3.3)	Yes	Some. Between most stringent recommended levels (in rooms with low pollution background values) up to ~25 % protection compared to the environment (3.3)	Very low risk of build-up
AE 2	< 3,0 to 1,0	Can significantly reduce monthly, but not seasonal variations with medium amounts of moisture sorbent[a]	may struggle for part of the year, depending on environment (3.3)	Yes	Good. Between most stringent recommended levels up to ~50 % protection compared to the environment (3.3)	Low risk of build-up

Class Label	AER [day⁻¹]	**Capacity to buffer against external (RH) fluctuation**	**Capacity to maintain internal hygrometric conditions (RH)**		**Capacity to provide protection against the ingress of pollutants** [b]	**Pollutant accumulation from off-gassing showcase materials and/or objects**
			Passive control	Active control		
AE 3	< 1,0 to 0,4	Can significantly reduce monthly, and most seasonal variations with medium amounts of moisture sorbent [a]	may work for most environments (3.3)	Suitable with most control systems for most situations	Very good. Large showcases, and/or with hard and smooth materials (e.g. glass and aluminium), might not satisfy most stringent recommended levels.	Moderate risk of build-up
AE 4	< 0,4 to 0,1	can significantly reduce monthly, and seasonal variations with medium amount of moisture sorbent [a]	Yes	Yes	Very good. Nearly always satisfy most stringent recommended levels. Large showcases in naturally ventilated buildings or in conditioned buildings with insufficient chemical filtering in urban environments, might not satisfy most stringent levels.	High risk of build-up
AE 5	< 0,1	unlikely to be required for RH buffering or control, except in most extreme situations	Yes	Yes	Excellent. Very few showcases need this low AER.	Highest risk of build-up

[a] very high loading of moisture sorbent: e.g. 10 kg/m³ ; high loading of moisture sorbent: e.g 6 kg/ m³ ; medium loading of moisture sorbent: e.g. 3 kg/ m³.

[b] protection levels are based on showcases placed in indoor environment (3.3)

Active climate conditioning systems may offer an alternative. However, the risk of technical failure should be considered. The performance of many active systems is very temperature dependent.

Experience has shown that the air exchange rate influences active conditioning (see Table 1). Many manufacturers give indicative showcase volumes and air exchange rates that a certain active climate conditioning unit will work with and requirements for space around the unit, which should be adhered to. Humidifiers and dehumidifiers have large capacities and can successfully condition large showcases with high air exchange rates. If both humidifiers and dehumidifiers are used together, correct hysteresis settings on the control sensor are essential. Mixing chambers can be used for smoothening RH fluctuations induced by humidifiers and dehumidifiers units that run alternately. It comprises a space between the display volume and humidifier or dehumidifier units. For greater effect, a mixing chamber is possibly equipped with moisture sorbent. Several units based on Peltier coolers and water reservoirs are available. Many have limited dehumidification capacity and can struggle at high room RH or high temperatures.

5.1.2 Air exchange rate measurements

Two methods adapted from building measurement standards are suitable for measuring showcase air exchange rates. They measure:

— tracer gas concentrations,

— air pressure differences.

Measuring showcase airtightness (3.1) to estimate protection against the environmental factors outlined in the previous section (see 5.1.1) is typically achievable with the tracer gas decay method. This is because it measures air exchanges resulting from the complex interplay between the construction of the showcase, and a variety of environmental contributions that often vary over time (see C – Physics of showcase air exchange). As a consequence, air exchange rates measured by tracer gas decay vary according to the changing ambient environmental conditions. For this reason, tests running over periods longer than one day are recommended to obtain an average air exchange rate; arriving at results representative of eventual exhibition conditions. See E for an example of air exchange rate measurement procedure by tracer gas decay.

Measuring the extent of showcase air exchange via gaps is typically achievable with air pressure difference methods, e.g. air pressure difference decay, constant air pressure difference. With these methods air exchange is measured under a consistently controlled test environment (3.3) which dominates over ambient environmental conditions. As a result, air exchange rates measured by air pressure methods are less subject to changing ambient environmental conditions; according to the unchanging construction/geometries of the showcase and its gaps. This high test repeatability stems from its mechanically-induced air exchange, which also enable tests to be completed in minutes. See Annex F.

Before taking air exchange rate measurements, the objective/s shall be clearly defined. This can help to choose the suitable measurement method/s; especially in terms of the test duration, equipment and environmental conditions. Unless preliminary tests are being undertaken, showcases shall be tested as part of their final assessment, with all features installed, e.g. security/lighting devices and wiring. Sealing surfaces and seals on all openings should be cleaned, and openings properly shut with all locks engaged.

The objectives may be to determine the:

— construction quality of showcases versus targets from specifications in procurement contracts with showcase suppliers, or from ad hoc exhibition needs,

— lifetime/amount of sorbent needed for buffering RH (see also Annex G, G.2)

- lifetime/amount of sorbent needed for controlling RH to a limit/threshold (see also G.3)
- protection of objects from externally generated pollutants (see also G.2)
- accumulation of internally generated pollutants (see also G.4)
- venting of internally generated pollutants (see also G.4)
- remedial alterations to airtightness (3.1) made during maintenance or retrofitting of door-gaskets, hinges, joints, gas struts, vertical lift systems and joints resealing around lighting/cableruns, etc. on existing showcases,
- alterations to airtightness (3.1) made after relocating existing showcases,
- influences of ageing and wear on alterations to airtightness (3.1) of existing showcases.

Active microclimate conditioning systems will interfere with accuracy of airtightness (3.1) measurements, so should be turned off and have any plumbing connections closed.

Before or after taking air exchange rate measurements, searching for leaks might be appropriate (see Annex D).

Further information can be found in the Annexes:

- the physics of showcase air exchange (Annex C),
- the influence of showcase design on air exchange (see prEN 15999-1:2023, Annex B),
- Example of air exchange rate measurement procedure by tracer gas decay (Annex E),
- Example of air exchange rate measurement procedure by constant air pressure difference (Annex F).

5.1.3 Protection against adverse climate

5.1.3.1 General

Showcases can be designed to provide appropriate climate conditions for the long term preservation of objects. Relative humidity (3.7) and temperature are the principal climate parameters, but pollution shall be considered for many materials as well. Relative humidity (3.7) of air is linked to the air temperature. A temperature increase of 1°C can make the relative humidity (3.7) decrease about 2 % to 3 %.

NOTE An enthalpy-entropy chart, a so-called Mollier-diagram, can be consulted to determine such changes. For example: the relative humidity (3.7) in air with a temperature of 25 °C and a constant humidity mixing ratio of 9,9 g/kg, will drop from 50 % to 47 % when the temperature rises to 26 °C.

Four different qualities of showcases are described below to control its microclimate performances:

- Hygrometric half-time,
- Buffering against external relative humidity (3.7) fluctuation,
- Capacity to maintain internal hygrometric conditions (RH), and

— Thermal performance.

Whilst humidity buffering (3.4) is suitable if the room average relative humidity (3.7) is acceptable, there are often occasions when it is desired to keep the showcase average relative humidity (3.7) significantly different to the room.

The targeted relative humidity (3.7) conditions for an object are obtained by selecting a showcase with a suitable hygrometric half-time (5.1.3.2) and corresponding replacement cycle of the moisture sorbent.

5.1.3.2 Hygrometric half-time

The capacity of a showcase to buffer against fluctuations in room relative humidity (3.7), or to maintain a microclimate relative humidity (3.7), is most easily expressed as the hygrometric half-time. The hygrometric half-time depends on two chief factors: (1) airtightness of the showcase envelope, and (2) the type, amount (loading for the moisture sorbent) and buffering material/s in the display space and / or technical compartment (see Formula (I.1) in I).

NOTE Consider that showcase construction, dressings, exhibit can also be hygroscopic.

A long hygrometric half-time signifies a large humidity buffering (3.4) capacity. The objectives for installing a certain amount and type of suitably conditioned moisture sorbent are to:

— adjust the microclimate RH to the target interval,

— increase the duration that the target microclimate RH can be maintained.

Examples for the calculated approximation of the hygrometric half-time are given in I.

The hygrometric half-time of an existing showcase can be calculated from internal and external relative humidity (3.7) data, see Annex J. When specifying existing showcases, the hygrometric half-time shall be quoted. When specifying new showcases, the anticipated showcase air exchange rate, and the volume of the technical compartment for moisture sorbent, shall both be quoted. These allow estimation of the hygrometric half-time. Hygrometric half-times are expressed in the following categories given in Table 2.

Table 2 — Categories of hygrometric half-time with some indicative uses

Class Label	**Hygrometric half-time (days)**	**Example of use (the actual suitability is subject to environmental climate parameters)**
HH 6	≥ 800	extreme climates: RH over 80 % for considerable amount of time (any kind of castle or underground building, as tunnels, mines, bunker, marine environment)
HH 5	< 800 to 400	Seasonal variations of 50 %
HH 4	< 400 to 200	Seasonal variations of 40 %
HH 3	< 200 to 100	seasonal buffering
HH 2	< 100 to 50	Seasonal variations of 20 %