SLOVENSKI STANDARD
oSIST prEN 15757:2008
01-april-2008

Varstvo kulturne dediġļ ine - Specifikacije za temperaturo in relativno vlaģnost za omejitev klimatsko pogojenih mehanskih poġkodb organskih higroskopskih materialov

Conservation of Cultural Property - Specifications for temperature and relative humidity to limit climate-induces mechanical damage in organic hygroscopic materials

Erhaltung des kulturellen Erbes - Festlegungen für Temperatur und relative Luftfeuchte zur Begrenzung klimabedingter mechanischer Beschädigungen an organischen hygroskopischen Materialien

Conservation des biens culturels - Spécifications applicables à la température et à l'humidité relative pour limiter les dommages mécaniques causés par le climat aux matériaux organiques hygroscopiques

Ta slovenski standard je istoveten z: **prEN 15757**

ICS:

97.195

oSIST prEN 15757:2008 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 15757

January 2008

ICS

English Version

Conservation of Cultural Property - Specifications for temperature and relative humidity to limit climate-induces mechanical damage in organic hygroscopic materials

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Ref. No. prEN 15757:2008: E

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Foreword

This document (prEN 15757:2008) has been prepared by Technical Committee CEN/TC 346 “Conservation of Cultural Property”, the secretariat of which is held by UNI.

This document is currently submitted to the CEN Enquiry.

Introduction

This European Standard gives general specifications for temperature (T) and relative humidity (RH) to preserve cultural heritage by limiting mechanical damage induced by strain-stress cycles of organic materials in indoor environments of museums, galleries, archives, libraries, churches and historical buildings

Materials may be divided into classes, depending on their response to relative humidity (RH):

Class 1: materials having a negligible vulnerability to RH variability, e.g. gold, glass, fossils. No special specifications for T and RH are necessary for this Class.

Class 2: porous materials impregnated with hygroscopic salts, metals sensitive to corrosion or to hydrolysis e.g. marine or archaeological remains, ceramics or heavily oxidised metals from excavations, photographic materials, objects made of cellulose acetate or nitrate. These should be preserved in a constant, dry atmosphere. Such target T and RH intervals are specified in other European Standards.

Class 3: metastable minerals that may suffer for humidity-related phase transition, deliquescence, efflorescence, and/or hydration, e.g., thenardite, mirabilite, hanksite, melanterite, borax, bonattite. Each of these minerals should be preserved within precise T, RH intervals, which are the same for all samples of the same material. Such target intervals are specified in other European Standards.

Class 4: organic materials susceptible to fracture and deformation, or composite objects including hygroscopic materials, with high vulnerability to RH variability, e.g. wooden artefacts, paints, books, organs, bone, ivory, leather or textiles fixed to frames. These need individual T, RH intervals being conditioned by the past climate history of each object; however, some general recommendations are possible, as follows.

The determination of values and allowable variations of T and RH which are optimal for the preservation of Class 4 objects is not simple due to the variety and complexity of the materials and the objects they comprise. Temperature has a direct effect on preservation but also an indirect one as it controls RH of the air. Changes in ambient RH produce changes in the equilibrium moisture content (EMC) as hygroscopic materials absorb and release moisture to adapt to the continually changing environment. The variations in EMC produce dimensional changes of the materials which may lead to high levels of stress and mechanical damage. For this reason a stable climate is fundamental for preservation.

The variability in T and RH should not be considered only from the static point of view of allowable levels or ranges, but also from the dynamic point of view, i.e. temporal features like rate of change, duration of cycles and frequency at which cycles are repeated should be taken into account. When cycles repeat before the material has relaxed, it accumulates internal stress, which in turn may lead to microscopic or macroscopic forms of deterioration.

The deterioration is of cumulative nature and progresses with the number and the intensity of the individual environmental hazards. T and RH variability accelerates material ageing although this is not always perceptible to human eye. The vulnerability to deterioration mechanisms increases with ageing and damage is irreversible. The same T and RH fluctuation may generate different effects in relationship to the object type and its ageing.

When past T and RH fluctuations accumulated enough internal stress to create fractures, these fractures open and close as expansion joints, with the result of widening the interval of acceptable T, RH fluctuations. The material is said having “acclimatized” because now has a different response, i.e. less sensitivity, to the T, RH fluctuations. This acclimatisation should not be considered a positive factor, because is due to internal fracturing and actually is a form of damage.

Given the extreme complexity of the response of historic materials to variation of T and RH, this standard lays down general specifications to limit climate-induced mechanical damage of Class 4 objects. Therefore the standard deals with a selected category of damage and does not cover other important deterioration processes influenced by microclimatic factors like corrosion reactions, biodeterioration, dissolution of materials due to deliquescence and other. The specifications for microclimatic conditions limiting deterioration phenomena other than mechanical damage are dealt with separately by other European Standards.

1 Scope

This European Standard gives general specifications for temperature and relative humidity to limit climate-induced mechanical damage of absorbing moisture, organic materials, especially in indoor environments of museums, galleries, archives, libraries, churches and modern or historical buildings.

2 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 11799 *Information and documentation – Document storage requirements for archive and library material*

3 Terms and definitions

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

3.1
active control
use of devices that introduce or remove heat or moisture, or force ventilation

3.2
air temperature (T)
temperature read on a thermometer which is exposed to air in a position sheltered from direct solar radiation or other energy sources [1]

3.3
climate history
description of the climate conditions in the microenvironment of a cultural heritage object, over a representative period of time, which affect its preservation

3.4
deterioration
any form of alteration, material or aesthetic, which makes worse state or lowers value of the cultural heritage object

3.5
equilibrium Moisture Content (EMC)
moisture content at which a hygroscopic material neither loses nor gains moisture from the surrounding atmosphere at given RH and T values

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[1] Definition taken from WMO (see Biliography).

3.6
Heating, Ventilating or Air Conditioning Systems (HVAC)
active systems operated to control air temperature (heating), air temperature and humidity (air conditioning), or ventilation in a building

3.7
historic climate
climate conditions in the microenvironment where a cultural heritage object has always been kept, or has been kept for a long period of time and has acclimatized to it

3.8
hygroscopic material
material absorbing moisture when the environmental relative humidity rises, and loses moisture when relative humidity drops

3.9
indoor environment
place within a building where cultural heritage objects are preserved

3.10
passive control
control of heat transfer, moisture or ventilation in a natural way, without any active control measures

3.11
Relative Humidity (RH)
ratio of the actual vapour pressure of the air to the saturation vapour pressure[2]

4 General recommendations for organic hygroscopic materials

Ideally, high RH levels should be avoided. On the other hand, too low RH levels might reduce too much the equilibrium moisture content (EMC), causing structural damage to some materials. Therefore, the optimum RH set-point is usually specified at a mid RH range for a number of materials. However, a different approach must be adopted for real artefacts kept over many decades, or even centuries, in the same particular indoor environment. Such artefacts have adapted to these particular conditions, which might have involved their permanent structural change as deformation or fracturing.

Therefore, it is possible to establish best T and RH intervals for the preservation of materials but T and RH intervals recommended for real artworks should not be different from their historic climate to which they have acclimatized.

For a real artwork, any change from this particular historic climate is risky, even though the new conditions may appear ‘better’ for the preservation. If the change is sudden, the strain-stress forces may generate a climatic ‘shock’ leading to damage. Even if the change is slow, it may still generate stress, which is not tolerable especially by the most vulnerable or complex artefacts and leads to damage.

Therefore, the strategy of the this standard focuses on maintaining the same climate both in terms of ranges and temporal variability of T and RH, to which the materials have acclimatized for a long time if this climate has been proved not to be harmful.

A well-preserved object always kept in its historical climate remains in a safe environment and its conditions are satisfactory for a long time. This is a limitation that guarantees a good preservation. However, in the case one wants to depart from this safe area, he should be aware of entering an obscure, risky condition, so that a

[2] Definition taken from Am Met. Soc. 1971 (see Biliography)

careful, frequent monitoring of the state of preservation is necessary to detect the early deterioration symptoms and return to safer conditions.

NOTE In the case of objects composed of more than one material, possibly belonging to different classes, the problem becomes more complex and interactions of the materials should be evaluated. In the case of synergy between individual responses of the materials, the vulnerability of such artefacts may be even greater than that of their most vulnerable component. However, the specifications concerning stability of T and RH and the importance of maintaining the historic climate remain generally valid.

5 Specifications for T and RH of organic hygroscopic materials

5.1 Determination of Priorities

Changes in the equilibrium moisture content (EMC) of organic hygroscopic materials induce dimensional changes, internal strain-stress cycles and risk of yield or failure. The risk is higher for anisotropic materials than for isotropic ones.

If objects contain hygroscopic materials for which changes in RH have more effect than changes in T on their EMC, and the resulting dimensional change, RH should be kept as constant as possible.

If objects contain hygroscopic materials with largely different coefficients of thermal expansion which can be significantly affected by temperature change, the requirements for stability of both RH and T should be considered and balanced.

5.2 Constancy and homogeneity

When RH has priority over T, RH should be constant in time, i.e. average levels, ranges and rates of variations should remain unchanged, and homogeneous in space, i.e. strong gradients, sources and sinks of heat or moisture should be avoided.

Stabilising RH within the target range around the average values typical of the climate history of the room may improve conservation. The preferable target range should not exceed the historic variability to which the artefact has acclimatized, and should be based on climate monitoring for a minimum period of one year. The method to determine the target range for RH is specified in the Annex A.

In general, avoiding short-term fluctuations and cycles, reduces steep variations i.e. high variation rates. Daily cycles should be avoided or attenuated, i.e. RH should kept constant during day and night. The range of seasonal cycles should be preferably reduced.

When RH and T have the same priority, the above specifications hold also for T.

The RH constancy may be obtained in one of the following ways:

- when the moisture content in air is constant: keeping T as constant as possible,
- when the moisture content in air is variable: varying T in order to keep RH constant (when changes in T are not relevant),
- when the moisture content in air is variable: adding or removing moisture to the air, without affecting T (when changes in T are relevant),
- when the moisture content in air is variable: combining the two above solutions (when T changes are not relevant).

For leather and parchment, a gentle cycling within a narrow RH interval at moderate T and RH levels is acceptable.

5.3 Priority of historic climate

When the conservation of objects with organic materials is satisfactory, the historic climate in the room, including average RH levels, the range of variability of the natural cycles, e.g. seasonal or daily, and the rates of change should be kept unchanged. The only acceptable changes are improvements toward more stationary conditions. The state of conservation has to be examined by a conservator-restorer.

When an object is moved for restoration or exhibition, the historic climate should be retained as accurately as possible. This holds also for transport or storage.

5.4 Further specifications

Some materials like paper or photographs require storage under specific climate conditions (e.g. low temperature). The list of materials belonging to this sub-class and the recommended T and RH intervals is specified in ISO 11799.

If, for whatever reason, the indoor climate is to be changed from the historic conditions, or if an object with organic elements is to be moved into new climate, studies should be undertaken to evaluate the adaptation of the object to the new T and RH conditions, taking into account the storage history and the response of the object.

If, for whatever reason, the historic climate is to be changed, changing the T and RH should be done at a very slow rate in order to allow a gradual adaptation. It is also necessary to continually verify whether the object continues to adapt to the new conditions without suffering deterioration. When deterioration appears, the ongoing T and RH change should be stopped.

5.5 Measures for Climate Control

5.5.1 Passive and active control of T and RH

Passive control is in general preferable to the active one (e.g. HVAC). Whenever possible, it is advisable to place objects particularly vulnerable to T and RH variability in locations naturally having the highest level of stability.

Active control of the climate, i.e. HVAC, should be limited as far as possible and should be aimed at compensating the daily cycles, i.e. keeping the T and RH constant by day and night, and at attenuating the seasonal ones. Abrupt on/off changes should be avoided because they generate dangerous step changes of T and RH repeated daily. Active systems always constitute a potential risk for conservation because of possible drift, failure, improper use or calibration. For this reason, they need continuous maintenance and control.

Vulnerable objects should be placed far from natural or artificial sources or sinks of heat, moisture and radiation, and aside from air currents.

5.5.2 Heating for thermal comfort versus conservation needs

Generally, winter heating may lower the RH too much.

Allowing the temperature to decrease should optimally control excessive drops in RH.

Especially in historic buildings, it is not advisable to compensate the RH drop by supplying moisture with the use of humidifiers, which might generate condensation on cold surfaces. This does not apply to modern highly insulated and airtight buildings like many museums.

People may feel uncomfortable at lower T levels compatible with the needs for conservation. In such a case, a compromise should be found between the two needs. For example, staff and visitors may tolerate relatively low T levels during short visiting times, if they are suitably clothed.