SLOVENSKI STANDARD
SIST EN 17488:2021

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Ohranjanje kulturne dediščine - Postopek za analitično vrednotenje pri izbiri metod za čiščenje poroznih anorganskih materialov, uporabljenih pri tej kulturni dediščini

Conservation of cultural heritage - Procedure for the analytical evaluation to select cleaning methods for porous inorganic materials used in cultural heritage

Erhaltung des kulturellen Erbes - Methodologie für die analytische Prüfung zur Auswahl von Reinigungsverfahren von porösen anorganischen Objekten des kulturellen Erbes

Conservation du patrimoine culturel - Procédure pour l'évaluation analytique et le choix des méthodes de nettoyage des matériaux inorganiques poreux dans les bâtiments d'intérêt patrimonial

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English Version

Conservation of cultural heritage - Procedure for the analytical evaluation to select cleaning methods for porous inorganic materials used in cultural heritage

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COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 17488:2021) has been prepared by Technical Committee CEN/TC 346 “Conservation of Cultural Heritage”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2021, and conflicting national standards shall be withdrawn at the latest by December 2021.

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

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Introduction

Cleaning is the removal of unwanted material from an object surface or near-surface.

A cultural heritage object is irreplaceable and while cleaning is undertaken for object conservation, its effects are irreversible. Failure to consider and address the technical problems which can arise during cleaning may cause irrevocable damage to an object. Cultural heritage should be cleaned using the least disruptive/invasive procedure possible in order to best preserve it.

Furthermore, an inadequate or inappropriate intervention may cause, or increase, future deterioration processes or eliminate materials which are undocumented or which would allow a greater understanding of the history of an object.

The actions required for cleaning involve a degree of risk for the object and therefore demand extreme caution. The chosen methods for cleaning should not be harmful to the object, the operator, the surroundings /environment, or users of the site.

Cleaning operation needs to take into account the compatibility definition (EN 15898) as the “extent to which one material can be used with another material without putting significance or stability at risk”. Extending the definition of compatibility to the cleaning action a “compatibility analysis” should therefore ascertain how cleaning actions (in terms of effectiveness and harmfulness) would impact on the significance and stability of the heritage object.

A successful cleaning strategy needs to adher to the strategy for the whole conservation-project in accordance with the conservation-process and the condition report (EN 16853, EN 16085 and EN 16095) and requires careful consideration of a number of aspects which include but are not limited to:

— the significance of the object;

— the aim of the cleaning;

— a clear definition of the nature of the materials to be removed and the rationale;

— context and sensitivity of the object to be evaluated (for example presence of polychrome and gilt surfaces);

— condition of the substrate, which may result in greater risk of harm during testing;

— form of the substrate (flat or carved surface).

These factors may exclude the use of one or more cleaning methods, which would be unsuitable.

This document takes into account the extreme variability of both the constituent materials and the conditions of the object, prescribing a procedure of analytical tests and comparing the extent of possible damage, which may result from each cleaning method tested.

“Harmfulness” indicates the level of risk of the variety of unwanted changes, which may appear not only in short-term but also in long-term after cleaning.

This may include the deterioration of the substrate, the change of porosity or surface roughness, the release of residual substances and formation of stains, which are not compatible with the material and or which could interfere with future conservation intervention.

The potential harmfulness of a cleaning method may be greater when it is applied to a deteriorated material.

Evaluation of effectiveness and potential harmfulness of cleaning methods need to be carried out on site by establishing a “trial area” as a preliminary step before any extensive work is started.

The process of cleaning requires careful evaluation throughout the work. This is initiated at the primary evaluation through the execution of trials and continues with the monitoring and optimization during the selected process. Trials aim to identify the method(s) of cleaning which produce an acceptable result at minimum risk to the object. Even an extensive sampling procedure may fail to identify all the conditions which exist on a cultural object therefore ongoing evaluation of the cleaning and the effects on the substrate are vital. If necessary, cleaning needs to be halted to re-appraise the methods used or to undertake further testing where areas of increased sensitivity or uncertainty are uncovered. This document identifies the means by which cleaning methods may be selected and evaluated as part of conservation interventions.

Unwanted interactions may arise from different substrate and cleaning method combinations. Some features of a given substrate may cause it to be particularly damaged depending on the method and circumstances of its use. These specific combinations will increase likelihood of damage. In some circumstances the synergistic effects can be easily predicted, e.g. a salt-laden wall masonry may be seriously affected by a water-based method, even if we know that generally this cleaning method is gentle and of low aggressiveness. The assessment of the synergistic effects should take into consideration that damage may emerge after some considerable elapsed time.

The initial assessment for a building or similar immovable object will take place on site with non-invasive systems. If necessary, it may be followed by appropriate micro-invasive or invasive laboratory analysis (Figure 1, Table 1).

As there are many different cleaning methods and the results can vary greatly it is necessary to carefully evaluate any proposed technique/system before trial and subsequent application. Reference to standard EN 17138 is required to undertake this.

Cleaning methods considered in EN 17138 were divided into four categories: Water cleaning, mechanical cleaning, physical cleaning and chemical cleaning. Each method requires different considerations in order to select the most appropriate investigations.

Assessment of harmfulness for chemical cleaning methods needs additional investigation with respect to the possible interactions between the chemicals and the products to be removed, notably the formation of by-products which could be harmful for the substrate. As a consequence, the procedure for chemical cleaning will follow a different pathway (Figures 2 and 6, Table 1).

The document is composed of two parts:

a) General procedure (Part A) to be applied when the evaluation of the effects of cleaning of a cultural heritage object surface is needed.

b) Analytical procedure (Part B) for testing cleaning methods under development on specimens of analogous material similarly decayed.

Cleaning methods and materials, which are under development should not be evaluated on cultural heritage objects surface but they should be tested according to the analytical procedure described in part B.

1 Scope

This document gives the test methodology for evaluation of both harmfulness and effectiveness of a cleaning method as applied to porous inorganic materials. Mural paintings and polychromy are excluded.

Evaluation includes the use of on-site analyses and/or laboratory studies.

The evaluation of the potential harm has a higher priority than the effectiveness in order to prevent overcleaning. It is important that cleaning is always at the minimum level deemed effective and that it respects the original surface and finishes. Overcleaning is a term used to indicate that irreversible damage has been done by the unnecessary removal of materials, which are part of the value of the object.

This document applies to:

a) Part A: all methods of cleaning, which have characteristics of parameterization and reproducibility (see EN 17138).

b) Part B: all new methods that are under development.

This document applies to evaluate the optimum methods for cleaning and the optimization of the parameters of the selected cleaning process.

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 15801, *Conservation of cultural property - Test methods - Determination of water absorption by capillarity*

EN 15886, *Conservation of cultural property - Test methods - Colour measurement of surfaces*

EN 16095, *Conservation of cultural property - Condition recording for movable cultural heritage*

EN 16096, *Conservation of cultural property - Condition survey and report of built cultural heritage*

EN 16302, *Conservation of cultural heritage - Test methods - Measurement of water absorption by pipe method*

EN 16455, *Conservation of cultural heritage - Extraction and determination of soluble salts in natural stone and related materials used in and from cultural heritage*

EN 16515:2015, *Conservation of Cultural Heritage - Guidelines to characterize natural stone used in cultural heritage*

EN 17138:2018, *Conservation of Cultural Heritage - Methods and materials for cleaning porous inorganic materials*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
cleaning effectiveness
ability to remove unwanted material

3.2
harmfulness
any undesired change in the substrate to be cleaned, except the removal of the unwanted material

3.3
invasive analysis
requires the removal of powder or of a fragment from the surface or from the bulk of the object

3.4
micro-invasive analysis
no visible damage on the surface

Note 1 to entry: A small amount of material is collected (1 mg or less).

3.5
non-invasive analysis
contact between object surface and apparatus used for measurements is avoided; no material is removed from the object

3.6
sample
portion of material, ideally representative, removed from the cultural property for *scientific investigation*

[SOURCE: EN 16085:2012, 3.2]

3.7
specimen
part considered representative of the material constituting an object

Note 1 to entry: The specimen can have different origins and can be taken from:

— materials similar to those constituting the object under study (e.g. stone quarries);

— reference materials, for instance, specifically prepared comparative materials;

— available materials from the object.

Note 2 to entry: The number and dimension of the specimens can be different depending on difficulties encountered in sampling the required amount of material.

[SOURCE: EN 15886:2010, 3.11]

3.8
trial area
location where the cleaning method under evaluation is tested

3.9
unwanted material
substances to be removed indicated by the conservation plan

4 Abbrevations

The following list of analytical techniques is considered:

4.1 UVF: Fluorescence induced by Ultraviolet Radiation

4.2 pXRF: Portable X Ray Fluorescence

4.3 TLOM: Transmitted Light Optical Microscopy

4.4 RLOM: Reflected Light Optical Microscopy

4.5 UVOM: Ultraviolet Optical Microscopy

4.6 ESEM/SEM: Environmental Scanning Electron Microscopy/Scanning Electron Microscopy

4.7 WDS: Wavelength Dispersive Spectroscopy

4.8 EDS: Energy Dispersive Spectroscopy

4.9 FTIR: Fourier Transform Infrared Spectroscopy

4.10 Raman: Raman Spectroscopy

4.11 IC: Ion Chromatography

4.12 pH-m: pH measurement

4.13 WDT: Water Drop Test

5 General procedure (Part A)

5.1 Overview

Before starting to evaluate cleaning methods, a condition survey and a condition report are needed in accordance with standards EN 16095 and EN 16096.

The initial assessment for a building or similar immovable object should take place on site with non-invasive systems. Successively, if necessary, it may be followed by appropriate micro-invasive or invasive laboratory analysis (Figure 1, Table 1).

To facilitate the analytical evaluation of cleaning methods in each individual case the following systematic procedure is proposed. It consists of a number of consecutive stages as described in the flow chart of Figure 1. Due to the wide variability of each individual case, the whole sequence proposed shall be case specific and is up to the responsibility of the professional in charge.

Evaluation procedures depend also on time available and resources (budget and staff). In all cases, the outcome should be the best possible one for the object.

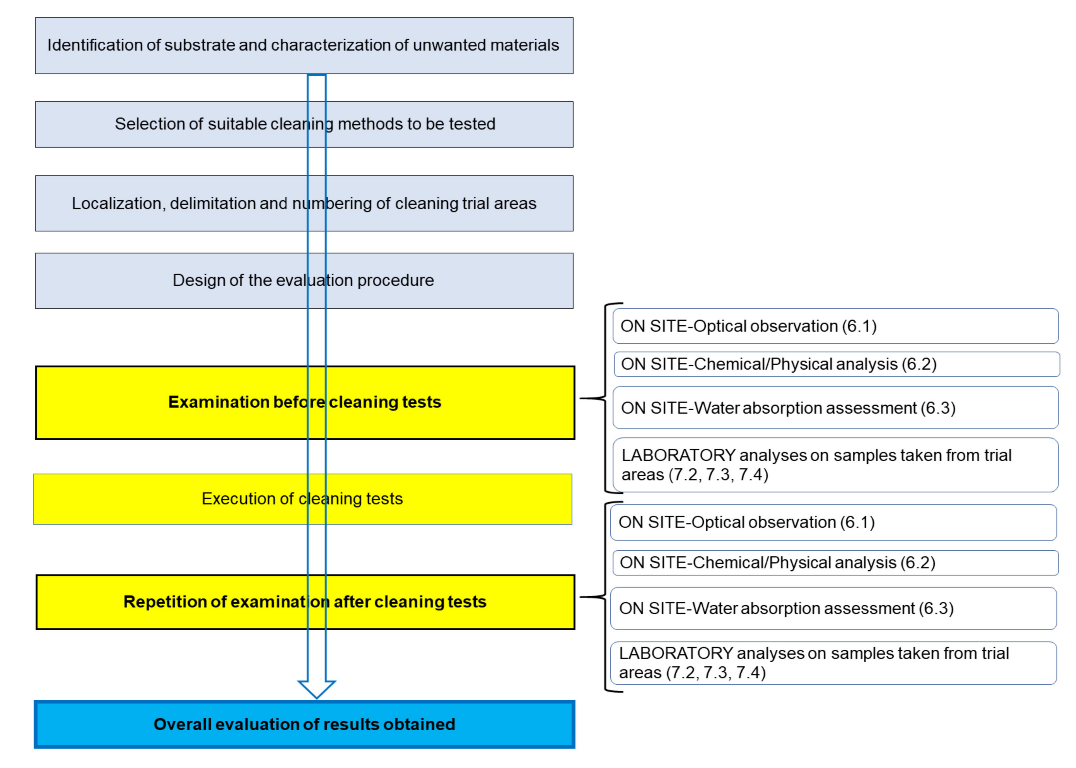

Figure 1 — Flow chart of the procedure for cleaning evaluation

5.2 Identification of substrate and characterization of unwanted materials

The chemical, mineralogical and the micro-structural characteristics of the material constituting the object shall be known or preliminarily identified (EN 16515) as well as the extent, nature and thickness of the unwanted materials to be removed.

The layer of unwanted materials and the altered surface of substrate shall be distinguished from each other at the investigation stage, so that the required degree of cleaning can be determined (see EN 17138:2018, 5.2).

The preliminary investigations using non-invasive systems should be carried out on a defined trial area selected as representative of the main surface material composition and cleaning problem.

The main non-invasive systems to be considered are:

a) portable microscope for optical observations;

b) portable XRF equipment for the identification of chemical elements;

c) portable fluorescence induced by UV radiation equipment for the identification of fluorescent compounds;

d) portable FTIR spectrometer especially in the presence of organic materials.

For laboratory investigations the procedure reported in EN 16515 (examination of specimens under stereo-microscope, petrographic examination, mineralogical analysis by X-ray diffraction XRD, examination by SEM/ESEM, chemical analysis) shall be performed.

The identification of organic components, not considered in EN 16515, shall be performed by FTIR spectroscopy and when necessary by GC-MS (gas chromatography and mass spectrometry).

5.3 Selection of suitable cleaning methods to be tested

As some cleaning methods are inappropriate where painted finishes are present, their presence or absence shall be established before any evaluation is started.

After the identification of the substrate and of the composition of unwanted materials a selection of suitable cleaning methods, according to the results obtained, is carried out on the “trial area”.

For the application of this document the following cleaning method categories are considered (see EN 17138):

a) water cleaning (restricted to the following: nebulous spray or intermittent mist spray, water spray at low pressure, steam cleaning, aqueous poultices or packs with absorbent material);

b) mechanical cleaning (restricted to the following: micro blasting, wet jet micro blasting, cryogenic cleaning);

c) chemical cleaning (application of organic solvents, application of acidic or alkaline solutions, application of chelating agents, application of surfactants, gel cleaning, application of ion exchange resins);

d) physical cleaning (laser cleaning);

e) those cleaning methods not adjustable by changing physical known parameters (such as cleaning with a lancet or a brush) are excluded by the present standard.

5.4 Localization, delimitation and numbering of the cleaning trial areas

Trial areas should be selected in order to be representative of the whole (constituting materials, surfaces and materials to be removed); if possible, trial areas should be unobtrusive. The trial areas should be the minimum size possible, taking into account the selected cleaning method, the significance of the object and the evaluation procedure, while still being representative.

The trial area(s) selection process should also take into account:

— the decay patterns, the type of substrate and the nature of unwanted material;

— the object size;

— the number of trial test required;

— the location where the impact of cleaning trials has the least detriment to the significance of the object, in case the trial should over-clean or otherwise damage an area;

— further optimization of the parameters of the selected cleaning process.

The description of trial areas selection and procedure is reported in Annex A, which is normative.

5.5 Design of the evaluation procedure and definition of a referenced cleaned area

The evaluation procedure is based on the investigations which are described in Clauses 6 and 7, which shall be carried out before and after cleaning respectively. The tests are also used to establish the level of cleaning that needs to be achieved and the actual level that can be achieved.

A flow chart of observations and analyses is reported in Figure 2 and Table 1.

The whole sequence reported is the ideal pathway for evaluation of potential harmfulness and effectiveness of cleaning methods tested in the trial areas. The adaptation of the procedure depends on specific features of the case (or object) under evaluation and is the responsibility of the professional in charge. Any variation shall be specified in the test report.

Investigation and interpretation of results shall be performed by professional(s) (e.g. conservation or material scientists, conservators/restorers) with appropriate competencies.

For most projects this will require a multidisciplinary approach.

The evaluation should be carried out before and soon after the cleaning operation. Monitoring over time is also possible, taking into account that decay, particulate deposition and several other phenomena can complicate the interpretation of results strictly referable to cleaning.

For some special cleaning methods an evaluation is also possible in real time during cleaning, such as the case for Laser Cleaning.

The trial area showing the most suitable result according to all the partners, taking into account the results of the evaluation (*in situ* and/or in the laboratory) should be preserved.

This area should be used as the visual reference of the expected cleaning result during all the cleaning campaign.

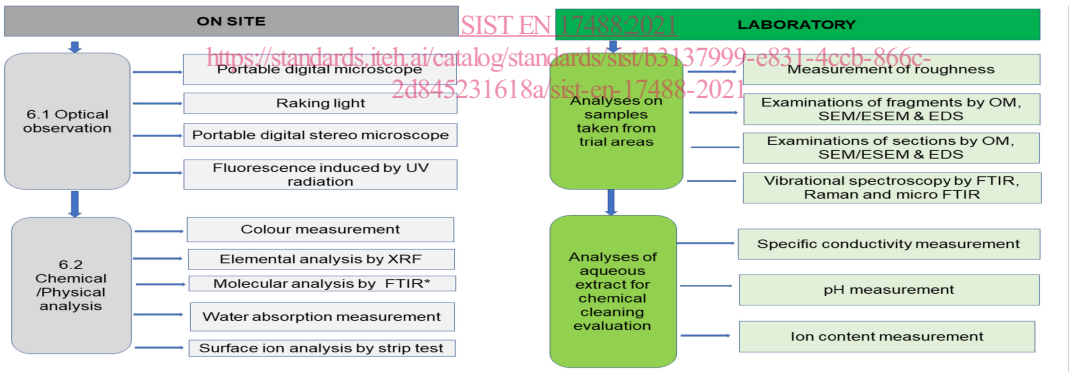

Figure 2 — Flow chart of observations and analysis related to cleaning methods

Table 1 — Observations and analysis in relation to the different cleaning categories

	Water cleaning	Mechanical /physical cleaning	Chemical cleaning [a]
6 On site surface investigations			
6.1 Optical observation			
6.1.1 Portable digital microscope	X	X	X
6.1.2 Raking light	X	X	X
6.1.3 Portable digital stereo microscope	X	X	X
6.1.4 Fluorescence induced by UV radiation	X	X	X
6.2 Chemical/physical analysis			
6.2.1 Measurement of colour	X	X	X
6.2.2 Elemental analysis by portable XRF	X	X	X
6.2.3 Molecular analysis by portable FTIR	X	X	X
6.2.4 Surface ion analysis	X	X	X
6.3 Water absorption assessment	X	X	X
6.3.2 Determination of water absorption by pipe method	X	X	X
6.3.3 Determination of water absorption by contact sponge method	X	X	X
6.3.4 Water drop test	X	X	X
7 Laboratory analysis on samples			
7.3.1 TLOM, RLOM and SEM/ESEM-EDS on fragments	X	X	X
7.3.2 TLOM, RLOM and SEM/ESEM-EDS on thin cross section	X	X	X
7.3.3 Vibrational spectroscopy (FTIR, micro-FTIR and Raman)	X	X	X
7.4 Surface morphology analysis (roughness)	X	X	X
7.5 Wet chemical analysis (on aqueous extract)			
7.5.2.2 Specific conductivity measurement	X		X
7.5.2.3 pH measurement	X		X
7.5.2.4 Ion content measurement	X		X

[a] Chemical cleaning is considered separately from the other methods due to the potential for deleterious reactions between chemicals and the unwanted materials to be removed.