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Paints and varnishes — Natural weathering of coatings — Exposure and assessment

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 139, Paints and varnishes, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 2810:2004), which has been technically revised. The main changes compared to the previous edition are as follows:

— in Clause 4, the list in b) has been amended by radiant exposure and temperature;

— the time of wetness has been deleted from the list of additional observations on climate in A.2 and replaced by a note with the reference to ASTM Practice G84;

— the climate classification in Annex B has been updated to ISO 877-1:2009;

— the text has been editorially revised and the normative references have been updated.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Paints and varnishes — Natural weathering of coatings — Exposure and assessment

1 Scope

This document specifies the conditions to take into consideration when selecting the type of natural weathering and the natural weathering procedure to determine the resistance of coatings or coating systems (direct weathering or weathering behind window glass).

Natural weathering is used to determine the resistance of coatings or coating systems (denoted in this document by coatings) to the sun's radiation and the atmosphere.

This document does not take into account special atmospheric influences, e.g. industrial pollution.

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.

ISO 1514, *Paints and varnishes — Standard panels for testing*

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 4618, *Paints and varnishes — Terms and definitions*

WMO Publication No, *8, Guide to meteorological instruments and methods of observation*, World Meteorological Organization, Geneva, 2012

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 and the following apply.

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

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

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

3.1
durability
ability of a specimen to resist the deleterious effect of its environment

3.2
time of wetness
period during which an exposed coating has surface moisture present on it

4 General

The durability of a coating during natural weathering depends on how, where and when the coating is weathered. Therefore, these parameters and the intended use of the coating shall be taken into account when exposures are carried out.

In particular, the following parameters shall be considered:

a) the location of the exposure site, for example industrial, marine, rural; in choosing sites, those which differ markedly in the type or level of pollution from the normal shall be avoided, unless they are appropriate to the intended end use of the coating under test;

b) the height, angle and orientation of the exposure rack; these parameters govern the extent to which the specimens are affected, for example by radiant exposure, temperature, dew, frost and atmospheric pollutants;

c) the nature of the terrain on which the rack is constructed (for example concrete, grass, gravel); the terrain may affect the climatic conditions around the specimen under test; it would rarely be feasible to select an ideal terrain in practice, but the effect of such variations in climatic conditions will be minimized by ensuring that all specimens are situated sufficiently high above the ground (see Clause 5);

d) whether the performance of the coating on the front and/or the back of the specimen is of interest; certain types of degradation, for example rust formation and/or mould growth, are frequently more severe on the shaded parts of the specimen;

e) the intended use of the coating, including its substrate, and whether the coating is to be washed or polished in service.

The results of tests on an exposure rack apply precisely only to the environment in which they were obtained.

Provided that the test conditions are reasonably appropriate to the intended end use, the relative performance of a number of coatings tested at the same time enables valid deductions to be drawn. It is recommended that each series of specimens under evaluation include coatings of known performance to act as reference standards.

The results of natural weathering may vary according to the time of year during which the tests are carried out. The influence of these variations is reduced if the exposure period is sufficiently long. The exposure period should be at least one year, or a multiple of one year. The reproducibility of the results is improved if the exposure period always starts at the same time of year, preferably in spring.

Natural weathering tests are normally carried out for a fixed period of time. However, in many cases it is preferable to define the test period in terms of a certain degree of degradation or by the radiant exposure (dosage) of solar radiation to which the specimen is to be subjected (see Clause 6). The latter procedure can reduce the influence of seasonal variations but does not eliminate it.

Radiant exposure can be determined by measurement of irradiance, and integration of the measurements over the period of natural weathering.

The climatic conditions shall be monitored, and a complete record shall be reported, together with the other conditions of weathering.

Care is required in the selection of test specimens of substrates with variable (anisotropic) properties, for example wood or steel. In these cases, replication of the tests is essential to avoid misleading results.

Washing and polishing during exposure affects the durability of the coating. It shall therefore be mentioned in the test report.

5 Exposure racks

Unless otherwise specified or agreed, use exposure racks on which the specimens are facing towards the equator. The specimens shall be firmly held on the racks by attachments made of stainless steel or other corrosion-resistant material, in such a manner that they are mechanically stressed as little as possible.

The exposure racks shall be constructed so that the atmosphere has free access to the specimens and that water that drains from one specimen does not drain onto another. In addition, the racks can be designed so that a portion of the specimens can be covered to allow evaluation between an exposed and a masked area. By using special devices, particular conditions may be simulated, for example by using a "black box" in accordance with SAE J 1976 to simulate automotive conditions or backing the test panel with plywood or other insulation material to simulate building side wall or roof area conditions.

Metal substrates for corrosion tests shall not be in electrical contact with metals during the exposure period or, as far as possible, in direct contact with wood or other porous materials. If specimens are supported in grooves, suitable drainage holes shall be provided to prevent accumulation of water.

Unless otherwise stated, the racks shall be constructed so that all specimens are supported either at a minimum height of 0,45 m above the ground or at a height sufficient to avoid contact with vegetation and to prevent damage.

The area beneath and in the vicinity of the racks shall be characterized by low reflectance and by ground cover typical of that climatological area. In desert areas, the racks shall be located on gravel, in most temperate areas on low-cut grass.

Usually the panels are supported at an angle of 45° to the horizontal. Depending on the intended end use of the coating, other angles may be agreed, for example 5° for automotive finishes or roof coatings, or vertical exposure for textured wall finishes.

NOTE When testing corrosion performance, it is appropriate to expose specimens vertically facing away from the equator as well as inclined at 45° and 5° facing towards the equator (see EN 13523-19).

Specimens facing away from the equator will remain wet for longer periods since they dry less rapidly than those exposed facing towards the equator. This leads to a higher tendency to corrode.

The racks shall be situated so that, at a sun height of 20° and more, no shadow falls on to the specimens.

When testing the durability of coatings for interior use which are exposed to radiation which has passed through window glass, racks that are covered by a window pane are used. Since, depending on the quality, the transmission of window glass in the UV range is different, the type of window glass shall be agreed upon between the interested parties for each particular case (see Clause 9).

6 Apparatus for measurement of climatic factors

6.1 Measurement of solar radiation

6.1.1 Pyranometers

Pyranometers are radiometers used to measure the total solar radiant energy incident upon a surface per unit time per unit area.

The energy measured includes direct and diffuse radiant energy as well as radiant energy reflected from the background.

Pyranometers shall meet at least the requirements for a second class instrument as defined by the World Meteorological Organization (WMO), WMO Publication No. 8. In addition, pyranometers shall be calibrated at least annually, and their calibration factor shall be traceable to the World Radiometric Reference (WRR) WMO Publication No. 8, Chapter 9.

6.1.2 Pyrheliometers

Pyrheliometers are radiometers used to measure the direct (beam) solar irradiance incident on a surface normal to the sun's rays.

The energy measured excludes diffuse radiant energy as well as radiant energy reflected from the background.

Pyrheliometers shall meet at least the requirements for a first class instrument as defined by the WMO Publication No. 8. In addition, pyrheliometers shall be calibrated at least annually, and their calibration factor shall be traceable to the WRR WMO Publication No. 8.

6.1.3 Total-ultraviolet radiometers

When used to define exposure stages, total-ultraviolet radiometers shall have a passband that maximizes the acceptance of radiation in the 300 nm to 400 nm, 295 nm to 385 nm, or any other commonly used total-ultraviolet wavelength region, and they shall be cosine-corrected to include ultraviolet sky radiation. Commercially available total-ultraviolet radiometers require annual calibration checks if they are deployed between latitudes 40° north and 40° south. Outside these latitudes, annual calibration is not a requirement but it is considered good practice.

6.1.4 Narrow-band ultraviolet radiometers

When used to define exposure stages, narrow-band ultraviolet radiometers shall be cosine-corrected if used in conjunction with either natural fixed-angle or glass-filtered exposures. They shall be calibrated following the manufacturer's instructions.

6.2 Other climate-measuring instruments

Instrumentation required for the measurement of air temperature, specimen surface temperature, relative humidity, rainfall, time of wetness, and sunshine hours shall be appropriate to the exposure method used and shall be agreed upon between the interested parties.

7 Test specimens

The simplest and most widely used test specimen is a flat panel of the appropriate substrate, but much useful additional information can be obtained by carrying out exposure tests on structures. This is particularly true of wooden assemblies such as window frames, where coating performance at the joints is of interest. Design features which allow accumulation and entrapment of water can also lead to premature coating degradation. Therefore, test specimens should preferably be included which show the characteristics of such structures.

Unless otherwise agreed, use standard test panels in accordance with ISO 1514, with the area of the panels at least 0,03 m^2 and no side less than 100 mm long.

Coat the panels with the product(s) under test by the appropriate method and dry (or stove) each coat in the specified manner for the specified time, followed (if appropriate) by conditioning or ageing. Coat both faces and the edges of the panels with the product under test, unless the panel would not be used in such manner. Alternatively, the back and edges may be coated with a good-quality protective paint [see Clause 4, d)].

If specified or agreed, particularly in the case of corrosion tests, provide uncoated areas on the specimen, preferably by one or more of the following methods.

a) After the specified drying time and immediately before placing the specimens on the exposure rack, make a straight scratch or scribe mark through the coating to the substrate. To make the scratch, use an instrument with a hard tip. The scratch shall have a width of 0,2 mm to 1,0 mm, unless otherwise agreed. As the result of the test depends on, e.g. the depth of the scratch and the scratching tool used, the details of how the scratch was made shall be stated in the test report.

   NOTE Normally, vertical and/or horizontal lines are used. By agreement, diagonal criss-cross lines (a St. Andrew's cross) can be employed. However, in this case, the coating might flake where the lines cross which makes evaluation, e.g. by image analysis, difficult.

b) Before applying the product(s) under test, attach to the prepared specimen a strip of pressure-sensitive adhesive tape of agreed size at an agreed location. Coat the specimen in the normal way. Either directly after coating or immediately before placing on the exposure rack, carefully remove the tape. Clean off any residues of adhesive with a suitable solvent which does not affect the coating.

Determine the thickness, in micrometres, of the coating by using one of the non-destructive methods specified in ISO 2808. Provide the specimens with a suitable marking which is resistant to natural weathering.

The number of test specimens depends on

— the number of different properties to be investigated and the number of specimens required for each test method, and

— the number of times each test method is to be carried out before, during and after weathering.

If not otherwise specified or agreed, the number of test specimens shall be not less than three.

The use of reference specimens of known durability and of composition similar to that of the test specimen is recommended.

8 Procedure

After any conditioning or specified pre-aging, expose the specimens on the rack for the specified time or until the specified level of radiant exposure has been reached or until a defined degree of degradation is reached.

If specified, wash all or part of the specimen at the required intervals. If only part of the specimen is to be washed, it is preferable to wash a strip on the right or left of the specimen, rather than at the top or bottom. It can also be necessary to define exactly the particular area to be washed. When the specimen-washing procedure is not specified in detail, use water in accordance with ISO 3696, grade 3, to which a suitable wetting agent has been added. Apply the washing solution with a soft brush or soft sponge, subsequently rinsing the surface thoroughly with water of grade 3, avoiding mechanical damage.

If specified, wash and polish all or part of each specimen at the required intervals, using the specified polish.

Examine the specimens at defined intervals, separately noting the resistance of the coating on the front, back, edges or bare areas. Examinations shall be at intervals appropriate to the rate of degradation, for example for change of colour, for loss of gloss, for blistering of the coating and for signs of corrosion of the substrate. If specified, also examine with ×10 magnification for cracking, blistering of the coating and for signs of corrosion of the substrate. Examine for signs of chalking by pressing and rotating (or wiping) a piece of velvet of contrasting colour over the surface, for example in accordance with the method described in ISO 4628-7.

After the specified period of exposure, carry out a final examination of the coating. If it is required to examine the substrate for signs of attack, remove the coating by the specified method.

9 Supplementary test conditions

For any particular application of the test method specified in this document, more details, in addition to those in the preceding clauses, might be required.

To enable the method to be carried out, the following test conditions shall be laid down as appropriate:

a) the material, the thickness and the surface preparation of the substrate;

b) the method of application of the coating materials under test to the substrate;

c) the duration and conditions of drying (or stoving) and ageing (if applicable) of the coating, the intervals between coats and the period of conditioning before exposure;

d) the thickness, in micrometres, of the dry coating and the method of measurement in accordance with ISO 2808, and whether it is a single coating or a multicoat system;

e) whether bare areas are to be provided on the specimen and, if so, their size and position and by what means they are to be made;

f) details of any periodic washing or polishing procedure to be carried out during the course of exposure;

g) any particular requirements regarding the exposure location;

h) the duration of the test;

i) which properties of the coating are to be evaluated prior to, during and after exposure, and the standards to be used;

j) where requested, the method of removal of the coating from the substrate;

k) if used, the transmittance characteristics of the glass, if measured, and thickness (all interested parties should agree upon the wavelengths at which transmittance is reported).

These test conditions should preferably be agreed between the interested parties and can be derived, in part or totally, from an international or national standard or other document related to the product under test.

10 Evaluation of properties

Measure the specified or agreed properties of the coating (see Clause 9) prior to, during and after the exposure, e.g. in accordance with ISO 2813, ISO 3668, ISO 4628-1, ISO 4628-2, ISO 4628-3, ISO 4628-4, ISO 4628-5, ISO 4628-6, ISO 4628-8, ISO 4628-10 and/or ISO 18314-1.

11 Precision

The principle of repeatability and reproducibility is not applicable to this document. However, experience has shown that for test specimens exposed under the same test parameters at the same exposure site a comparable ranking of products can be obtained.

12 Test report

The test report shall contain at least the following information:

a) all information necessary for complete identification of the product tested;

b) a reference to this document, i.e. ISO 2810:2020

c) the supplementary test conditions referred to in Clause 9;

d) a reference to the international or national standard, product specification or other document supplying the information referred to in c);

e) the weathering procedure used (direct weathering or weathering behind window glass);

f) the test details:

   1) exposure aspect (for example tilt and azimuth orientation);

2) location and details of exposure site (e.g. longitude, latitude, altitude, annual climate characteristics);

3) class and type of climate (examples are shown in Annex B, reference in test report if used);

4) nature of masking, backing, support and attachments, if used;

5) procedure used to determine the exposure stages;

6) exposure stages:

i) starting time;

ii) elapsed time (weeks, months, years);

iii) total solar radiant exposure, expressed in joules per square metre, including the method used to measure it, if it is measured (see 6.1).

7) details of washing procedure, if specified (see Clause 8);

g) details of the scratch, if made, and of the tool used to make it;

h) the test results as indicated in Clause 10, including

1) the intervals between removal of specimen from rack and property measurement, and

2) climatological data as specified in Annex A;

i) any items which were agreed between the interested parties;

j) any deviation from the weathering procedure specified;

k) any unusual features (anomalies) observed during the test;

l) the date of the test.

Annex A
(normative)

Environment and climate

A.1 Classification of environment and climate

A.1.1 Environment

A classification of environments, used especially to describe the environmental impact on steel structures, is given in ISO 12944-2 (which is based on ISO 9223). For general requirements for atmospheric corrosion field tests, including requirements for monitoring, see ISO 8565:1992, Clause 3.

Marine and industrial influences are likely to have a significant impact on the basic climatic conditions of a region. These particular conditions are referred to as the microclimate of the test site. In coastal regions, where the atmosphere can contain traces of salt but is generally otherwise clean, exposed specimens receive more solar radiation and are likely to degrade more rapidly than in comparable inland regions.

NOTE Certain coatings are known to degrade more rapidly in desert exposure sites than in coastal test sites.

In industrial areas, atmospheric pollution and dirt retained on the specimens reduce the effect of solar radiation, although the pollution and dirt can at the same time make the effects of moisture more pronounced.

A.2 Climate

Climates are divided into classes, each subdivided into several types. Annex B gives details of one such classification in use throughout the world. The classification is such that significant differences are to be expected between each class with respect to its effect on the weathering behaviour of paints.

A.3 Additional observations on climate

The general description of the climate at the exposure site by class, type and special conditions should preferably be supplemented by the following detailed observations.

a) Temperature:
   1) monthly mean of daily maxima;
   2) monthly mean of daily minima;
   3) monthly maximum and minimum.

b) Relative humidity:
   1) monthly mean of daily maxima;
   2) monthly mean of daily minima;
   3) monthly maximum and minimum.

c) Precipitation:
   1) total monthly rainfall, in millimetres;

2) total monthly time of wetness, in hours.

NOTE ASTM Practice G84 describes a procedure for determination of time of wetness. Other procedures can be used if mutually agreed upon by interested parties.

d) Other observations:

Other observations, such as wind speed and direction, incidence and nature of any atmospheric pollution, total ultraviolet radiant exposure (if measured) and any special local features, can also be recorded.

Annex B
(informative)

Classification of climates

The most widely recognized system for defining and classifying the various types of climate is based on the work of German climatologist Wladimir Köppen who introduced this climate classification system in 1928 and published modifications and improvements until he died in 1940. Köppen's classification system was originally developed for vegetation and has been modified by several researchers, but the most common modification in use today was developed by Glenn Trewartha of the University of Wisconsin in the USA. A full description of Trewartha's modification of Köppen's climate classification is described in Reference [20]. In this system, climates are classified into six basic types. Within each of the basic types, there are several different subtypes based on temperature and precipitation. These are described in Table B.1.

NOTE This information is taken from ISO 877-1:2009, Table A.1.