INTERNATIONAL STANDARD

ISO 11997-2

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Paints and varnishes — Determination of resistance to cyclic corrosion conditions —

Part 2: Wet (salt fog)/dry/humidity/UV light

Peintures et vernis — Détermination de la résistance aux conditions de corrosion cyclique —

Partie 2: Brouillard salin/sécheresse/humidité/lumière UV

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Foreword

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The committee responsible for this document is ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

This second edition cancels and replaces the first edition (ISO 11997-2:2000), which has been technically revised. The main technical changes are:

a) alternative test procedures have been added as an informative annex;

b) the supplementary test conditions (formerly Annex A) have been incorporated in the test report.

ISO 11997 consists of the following parts, under the general title *Paints and varnishes — Determination of resistance to cyclic corrosion conditions*:

— *Part 1: Wet(salt fog)/dry/humidity*

— *Part 2: Wet (salt fog)/dry/humidity/UV light*

This part of ISO 11997 is equivalent to ASTM D 5894, *Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)*.

Introduction

Coatings of paints, varnishes and similar materials are exposed to cyclic wet and dry corrosion and UV exposure conditions using specified salt solutions in cabinets in order to simulate, in the laboratory, processes occurring in aggressive outdoor conditions. Generally, valid correlations between such outdoor weathering and laboratory testing cannot be expected because of the large number of factors influencing the breakdown process. Certain relationships can only be expected if the effect on the coating of the important parameters (e.g. nature of the pollutant, spectral distribution of the incident irradiance in the relevant photochemical region, temperature of the specimen, type and cycle of wetting and relative humidity) is known. In contrast to outdoor weathering, laboratory testing in a cabinet is performed with a reduced number of variables, which can be controlled and therefore the effects are more reproducible.

The method described can give a means of checking that the quality of a paint or paint system is being maintained. The method is intended to provide a more realistic simulation of these factors than is found in traditional tests with continuous exposure to a static set of corrosive conditions. The method has been found to be useful in comparing the cyclic salt spray resistance of different coatings. It is most useful in providing relevant ratings for a series of coated panels exhibiting significant differences in cyclic salt spray/UV exposure resistance tested at the same time and to the same test cycle.

The cycle specified in this part of ISO 11997 has been found useful for air-drying industrial maintenance coatings on steel; other cycles may be used as required.

Paints and varnishes — Determination of resistance to cyclic corrosion conditions —

Part 2:
Wet (salt fog)/dry/humidity/UV light

1 Scope

This part of ISO 11997 specifies a test method of determining resistance of coatings to a defined cycle of wet (salt fog)/dry/humidity/UV light conditions using a specified solution.

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 1513, *Paints and varnishes — Examination and preparation of test samples*

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

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

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 4628-1, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 1: General introduction and designation system*

ISO 4628-2, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 2: Assessment of degree of blistering*

ISO 4628-3, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 3: Assessment of degree of rusting*

ISO 4628-4, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 4: Assessment of degree of cracking*

ISO 4628-5, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 5: Assessment of degree of flaking*

ISO 4628-6, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 6: Assessment of degree of chalking by tape method*

ISO 4628-8, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 8: Assessment of degree of delamination and corrosion around a scribe or other artificial defect*

ISO 4628-10, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 10: Assessment of degree of filiform corrosion*

ISO 11997-1:2005, *Paints and varnishes — Determination of resistance to cyclic corrosion conditions — Part 1: Wet (salt fog)/dry/humidity*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

ISO 16474-3:—[1)], *Paints and varnishes — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps*

ISO 17872, *Paints and varnishes — Guidelines for the introduction of scribe marks through coatings on metallic panels for corrosion testing*

3 Principle

A coated test panel is exposed to a cyclic wet (salt fog), drying, humidity and UV light test schedule and the effects of exposure are evaluated by criteria agreed in advance between the interested parties, these criteria usually being of a subjective nature.

4 Salt fog test solution

4.1 Prepare the spray solution by dissolving sodium chloride and ammonium sulfate in water of grade 1 or grade 2 quality as defined in ISO 3696 to give a solution with c(NaCl) = (0,50 ± 0,01) g/l and $c[(NH_4)_2SO_4]$ = (3,50 ± 0,01) g/l.

4.2 The salts shall be white and comply with the purity requirements given in Table 1.

Table 1 — Purity of salt

Impurity	Maximum mass percentage of impurity % (calculated on the dry salt)
Total	0,5
Iodine	0,1
Copper	0,001
Nickel	0,001

4.3 Filter the solution before placing it in the reservoir of the cabinet, in order to remove any solid matter which might block the apertures of the spraying device.

5 Apparatus

Ordinary laboratory apparatus and glassware, together with the following:

5.1 Artificial weathering cabinet, conforming to the requirements of ISO 16474-3, fitted with UVA 340 lamps and set to repeat a test cycle consisting of light (UV) at 60 °C black panel temperature and condensation in the dark period at 50 °C, unless otherwise specified. The cycle used is 4 h light (UV) and 4 h condensation.

5.2 Cyclic corrosion cabinet, conforming to the requirements of ISO 11997-1.

If the cabinet (5.1 or 5.2) has been used for a spray test, or for any other purpose, using a solution differing from that specified for the current test cycle, then it shall be thoroughly cleaned before use.

Other light sources and cabinets which may be used if otherwise specified or agreed are described in Annex A.

1) To be published.

6 Sampling

Take a representative sample of the product to be tested (or of each product in the case of a multi-coat system), as described in ISO 15528.

Examine and prepare each sample for testing, as described in ISO 1513.

7 Test panels

7.1 Material and dimensions

The test panels shall be of burnished steel complying with ISO 1514, and of minimum dimensions 150 mm × 70 mm × 0,3 mm.

7.2 Preparation and coating of panels

Prepare each test panel in accordance with ISO 1514 and then coat it by the specified method with the product or system under test.

The back and edges of the panel shall be coated with the product or system under test.

If the coating on the back and edges of the panel differs from that of the product under test, it shall have a corrosion resistance greater than that of the product under test.

7.3 Drying and conditioning

Dry (or stove) and age (if applicable) each coated test panel for the specified time under the specified conditions, and then condition them at a temperature and relative humidity as defined in ISO 3270 for at least 16 h with free circulation of air and without exposing them to direct sunlight. The test procedure shall then be carried out as soon as possible.

7.4 Thickness of coating

Determine the thickness, in micrometres, of the dried coating by one of the non-destructive procedures described in ISO 2808.

7.5 Scribing of panels

If specified, make a straight scribe through the coating to the substrate as described in ISO 11997-1:2005, 8.5, and ISO 17872.

8 Procedure

8.1 Carry out the determination in triplicate.

8.2 Expose at least one control specimen of similar composition and known durability with every test.

It is recommended that two control specimens, one of lower and one of higher durability, be included with each series of test panels.

8.3 Set up the cabinets as described in Clause 5 and allow equilibrium to be established. Always start the exposure in the artificial weathering cabinet.

8.4 Arrange the panels in the artificial weathering cabinet (5.1) and expose for 168 h.

8.5 Transfer the panels to the cyclic corrosion test cabinet (5.2) and expose for 168 h. One test cycle shall consist of 60 min salt fog at ambient temperature and 60 min dry at (35 ± 2) °C, unless otherwise

specified. The salt fog deposition rate shall be 1 ml/h to 2 ml/h, when collected over a continuous 24 h period (see ISO 11997-1).

8.6 Unless otherwise specified, repeat the cycles in 8.4 and 8.5 for a total test time of 1 008 h (6 weeks).

8.7 When moving between cabinets, the test panels shall be outside the cabinets for the minimum time possible. They shall also be rotated around the cabinets so that each panel spends an equal time in all areas of each cabinet.

9 Examination of test panels

9.1 Make a periodic examination of the panels as quickly as possible, taking care not to damage the surfaces under test. The cabinet shall be turned off for no more than 30 min in any 24 h period. The panels shall be examined during a dry phase. If this is not possible for any reason, turn off the cabinet, do not allow the panels to dry and restart the cabinet as soon as possible.

9.2 Conclude the test at the end of last cycle wet phase. Remove the panels from the cabinet and rinse with clean water to remove residues of salt solution from the surface. Immediately examine the test surfaces for signs of deterioration in accordance with ISO 4628-1, ISO 4628-2, ISO 4628-3, ISO 4628-4, ISO 4628-5, ISO 4628-6, ISO 4628-8 and ISO 4628-10.

NOTE 1 If specified or agreed, keep the panels in a standard atmosphere as defined in ISO 3270 for the specified period and examine the test surfaces for deterioration.

NOTE 2 If specified or agreed to examine the substrate for signs of attack, remove the coating by means of a non-corrosive paint remover unless otherwise specified.

10 Precision

No relevant precision data are currently available.

11 Test report

The test report shall contain at least the following information:

a) all details necessary to identify the product tested;

b) a reference to this part of ISO 11997 (i.e. ISO 11997-2);

c) the cycles and test solution used;

d) details of the preparation and evaluation of the test panels, including

   1) the material, dimensions and surface preparation of the substrate (see 7.1 and 7.2),

   2) the method of application of the test coating to the substrate, including all details of the backing of the panels (see 7.2),

   3) the duration and conditions of drying (or stoving) and ageing (if applicable) of coated test panels before testing (see 7.3),

   4) the thickness, in micrometres, of the dry coating and method of measurement in accordance with ISO 2808 (see 7.4), and whether it is a single coating or a multi-coat system,

   5) whether the substrate is to be scribed and details of the scribe (see 7.5);

e) the duration of the test (see Clause 8);

f) how inspection of the test coating is to be made and what characteristics are to be considered in evaluating its resistance to salt spray and UV light (see Clause 9);

g) the UV light cabinet conditions to use, if different from those specified (see 5.1);

h) the cyclic corrosion cabinet conditions to use, if different from those specified (see 5.2);

i) the results of the test, in terms of the stated requirements;

j) any deviation from the test procedure specified;

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

l) the date of the test.

Annex A
(informative)

Alternative test procedures

A.1 General

This annex gives information on the test procedures which may be used alternatively to the determination of resistance to cyclic corrosion conditions – Wet (salt fog)/dry/humidity/UV light. This part of ISO 11997 specifies a UV fluorescent lamp (UVA 340) only as a laboratory light source.

For light exposure tests, however, other light sources (e.g. a xenon arc lamp in ISO 16474-2, ISO 4892-2, ISO 2135 and ASTM G 155, and an open-flame carbon arc lamp in ISO 4892-4, ISO 2135 and ASTM G 152) are widely used. The combination of the light exposure test of such a lamp and the corrosion test (e.g. ISO 9227) or the cyclic corrosion test (e.g. ISO 11997-1, ISO 14993 and ISO 16151) is used for a similar purpose to Clause 5.

A.2 Procedure

Mount test specimens in the artificial weathering chamber, and expose them to the light. At the end of light exposure, remove them from the chamber and place the exposed test specimens in the corrosion chamber that has been arranged in good order and run the corrosion test or the cyclic corrosion test.

A.3 Test conditions

A.3.1 General

The following test conditions are examples; other conditions may be applied by the agreement between the interested parties.

A.3.2 Exposure to light

A.3.2.1 Xenon arc lamp

— Light source: Water-cooled or air-cooled long arc xenon lamp with daylight filter, conforming to the requirements of ISO 16474-2, ISO 4892-2 and ISO 2135

— Irradiance: 60 W/m^2 or 180 W/m^2 at 300 nm to 400 nm

— Black panel temperature: (63 ± 3) °C

— Relative humidity: (50 ± 10) %

— Light cycle: Continuous light

— Water spray: 102 min light/18 min light and spray

A.3.2.2 Fluorescent UV lamp

— Light source: Type 1 B fluorescent UV lamp, or Type 2 fluorescent UV lamp, conforming to the requirements of ISO 16474-3 or ISO 4892-3

— Temperature, condensation and light cycle:

  — Mode 1: 4 h of UV exposure at a black panel temperature of (60 ± 3) °C, followed by 4 h of condensation exposure without radiation at a black panel temperature of (50 ± 3) °C; or

  — Mode 2: 5 h of dry UV exposure at a black panel temperature of (50 ± 3) °C followed by 1 h of water spray, with continued exposure to radiation without temperature control

NOTE The temperature during the spray cycle depends on the water temperature, which is not controlled. For materials sensitive to spray water temperature, additional water-temperature control might be necessary.

A.3.2.3 Open-flame carbon arc lamp

— Light source: Open-flame carbon arc lamp with extended-UV filters, conforming to the requirements of ISO 4892-4, ISO 2135, ISO 16474-4 or ASTM G 152

— Irradiance: 75 W/m^2 at 300 nm to 400 nm

— Black panel temperature: (63 ± 3) °C

— Relative humidity: (50 ± 5) %

— Light cycle: Continuous

— Water spray: 102 min light/18 min light and spray

A.3.3 Corrosion

A.3.3.1 Salt spray

— Salt spray test, conforming to the requirements of ISO 9227

A.3.3.2 Salt spray/dry/wet

— Repeated cycles of 2 h of salt spray, 4 h of dry and 2 h of wet, conforming to the requirements of ISO 11997-1:2005 Cycle A or ISO 14993

A.3.3.3 Salt spray/wet/hot dry/warm dry

— Repeated cycles of 0,5 h of salt spray, 1,5 h of wet, 2 h of hot dry and 2 h of warm dry, conforming to the requirements of ISO 11997-1:2005 Cycle D

A.3.3.4 Acidified salt spray/dry/wet

— Repeated cycles of 2 h of salt spray, 4 h of dry and 2 h of wet, conforming to the requirements of ISO 16151:2005 Method A

Bibliography

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[2] ISO 4892-2, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

[3] ISO 4892-3, *Plastics — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps*

[4] ISO 4892-4, *Plastics — Methods of exposure to laboratory light sources — Part 4: Open-flame carbon-arc lamps*

[5] ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

[6] ISO 11341, *Paints and varnishes — Artificial weathering and exposure to artificial radiation — Exposure to filtered xenon-arc radiation*

[7] ISO 11507, *Paints and varnishes — Exposure of coatings to artificial weathering — Exposure to fluorescent UV lamps and water*

[8] ISO 14993, *Corrosion of metals and alloys — Accelerated testing involving cyclic exposure to salt mist, "dry" and "wet" conditions*

[9] ISO 16151:2005, *Corrosion of metals and alloys — Accelerated cyclic tests with exposure to acidified salt spray, "dry" and "wet" conditions*

[10] ISO 16474-2:—[2)], *Paints and varnishes — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

[11] ISO 16474-4:—[3)], *Paints and varnishes — Methods of exposure to laboratory light sources — Part 4: Open-flame carbon-arc lamps*

[12] ASTM G 152, *Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*

[13] ASTM G 155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*

2) To be published.

3) To be published.

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