
**Combined coatings on aluminium —
General specifications for combined
coatings of electrophoretic organic
coatings and anodic oxidation
coatings on aluminium**

*Revêtements combinés sur aluminium — Spécifications générales
pour les revêtements combinés appliqués sur l'aluminium composés
d'un revêtement organique obtenu par électrophorèse appliqué sur
un revêtement obtenu par anodisation*





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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 28340 was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 2, *Organic and anodic oxidation coatings on aluminium*.

Combined coatings on aluminium — General specifications for combined coatings of electrophoretic organic coatings and anodic oxidation coatings on aluminium

1 Scope

This International Standard gives specifications for the combined coatings of electrophoretic organic coatings and anodic oxidation coatings on aluminium used for architecture.

It specifies the characteristic properties of combined coatings on aluminium, outlines the test methods for checking these characteristic properties and specifies their required performance.

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 1463, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method*

ISO 2360, *Non-conductive coatings on non-magnetic electrically conductive basis materials — Measurement of coating thickness — Amplitude-sensitive eddy-current method*

ISO 2409, *Paints and varnishes — Cross-cut test*

ISO 2810, *Paints and varnishes — Natural weathering of coatings — Exposure and assessment*

ISO 2813, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20 degrees, 60 degrees and 85 degrees*

ISO 2859-10, *Sampling procedures for inspection by attributes — Part 10: Introduction to the ISO 2859 series of standards for sampling for inspection by attributes*

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

ISO 7599, *Anodizing of aluminium and its alloys — General specifications for anodic oxidation coatings on aluminium*

ISO 7668, *Anodizing of aluminium and its alloys — Measurement of specular reflectance and specular gloss of anodic oxidation coatings at angles of 20 degrees, 45 degrees, 60 degrees or 85 degrees*

ISO 8251, *Anodizing of aluminium and its alloys — Measurement of abrasion resistance of anodic oxidation coatings*

ISO 8993, *Anodizing of aluminium and its alloys — Rating system for the evaluation of pitting corrosion — Chart method*

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

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

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

ISO 15184, *Paints and varnishes — Determination of film hardness by pencil test*

AAMA 612-02, *Voluntary specification, performance requirements, and test procedures for combined coatings of anodic oxide and transparent organic coatings on architectural aluminum*

3 Terms and definitions

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

3.1 combined coatings

superimposed electrophoretic organic coating and anodic oxidation coating on aluminium

3.2 significant surface

part of the article covered or to be covered by the coatings, and for which the coatings are essential for service and/or appearance

3.3 standard sample limit sample

sample which defines the criteria for acceptable appearance

Note 1 to entry: This may be agreed between the surface processor and the customer.

4 Classes

The combined coatings are classified by corrosion resistance, which is specified in [5.6](#), resistance to accelerated weathering specified in [5.7](#), and resistance to cyclic corrosion/UV light specified in [5.8](#).

Performance requirements are given in [Table 1](#).

To test the corrosion resistance, the acetic acid salt spray (AASS) test (method A) or copper-accelerated acetic acid salt spray (CASS) test (method B) shall be carried out.

To test the resistance to accelerated weathering, the xenon-arc lamp exposure test (method A) or the open-flame carbon-arc lamp exposure test (method B) shall be carried out.

To test the resistance to cyclic corrosion/UV light, the AASS test (method A) shall be carried out or the CASS test (method B) after the ultraviolet (UV) lamp exposure test specified in [5.8](#). The selection of the test method should be agreed between the surface processor and the customer.

NOTE Classes and applied environments are given in [Table A.1](#).

Table 1 — Classes of combined coatings on aluminium

Characteristic property		Corrosion resistance		Resistance to accelerated weathering		Resistance to cyclic corrosion/UV light			
Test method		A	B	A	B	A		B	
		AASS	CASS	Xenon-arc lamp	Carbon-arc lamp	UV	AASS	UV	CASS
Testing time h	Class 4	1 500	120	4 000	3 000	240	1 500	240	120
	Class 3	1 500	120	2 000	1 500	240	1 500	240	120
	Class 2	1 000	72	1 000	750	240	1 000	240	72
	Class 1	—	24	350	250	—	—	—	—
Criteria		Corrosion: RN 9,5 or more		No remarkable colour change and chalking Gloss retention: 75 % or more		Corrosion: RN 9,0 or more			

5 Quality

5.1 General

The required quality for the applied products shall be chosen from the performances specified in [5.2](#) to [5.14](#) which should be agreed between the surface processor and the customer.

5.2 Appearance

The appearance shall be examined by the method specified in [7.2.1](#), and any visual surface defects, such as scratches, unevenness, peeling, which are unacceptable for the application, shall not be permitted. The quality should be agreed between the surface processor and the customer.

5.3 Colour

The colour and its tolerance level shall be examined by the method specified in [7.2.2](#), and the quality should be agreed between the surface processor and the customer.

5.4 Gloss

The specular gloss of the electrophoretic organic coating shall be examined by the method specified in [7.2.3](#), and the quality should be agreed between the surface processor and the customer.

5.5 Thickness of anodic oxidation coating

The thickness of anodic oxidation coating shall be measured by the method specified in [7.2.4](#), and the quality should be agreed between the surface processor and the customer. The average thickness of anodic oxidation coating, as specified in ISO 7599, shall be more than 5 µm. Furthermore, the minimum local thickness shall not be less than 80 % (4 µm) of the average thicknesses at three or more measurement points.

The total thickness of the combined coatings is not specified because specification is based on performance.

5.6 Corrosion resistance

The corrosion resistance of the combined coatings shall be tested by the AASS test specified in [7.2.5.2](#) or the CASS test specified in [7.2.5.3](#) and shall be evaluated by the degradation in appearance and the corrosion rate [rating number(RN)] for the test specimens. The selection of the test method should be agreed between the surface processor and the customer. The testing time and the quality of the combined coatings shall conform to [Table 1](#).

5.7 Resistance to accelerated weathering

The accelerated weathering resistance shall be tested by the xenon-arc lamp exposure test specified in [7.2.6.2](#) or the open-flame carbon-arc lamp exposure test specified in [7.2.6.3](#). The performance shall be evaluated by the visual degradation, such as colour change, chalking, and gloss-retention of the organic coating. The testing time and the quality of the combined coatings shall conform to [Table 1](#).

5.8 Resistance to cyclic corrosion/UV light

The resistance to cyclic corrosion/UV light shall be tested by the AASS test specified in [7.2.5.2](#) or the CASS test specified in [7.2.5.3](#), after having been tested by UV lamp exposure, as specified in [7.2.7](#). The performance shall conform to [Table 1](#).

5.9 Outdoor exposure

If required by the customer, the resistance to outdoor exposure shall be tested, and the exposure site, the testing time and the required performance should be agreed between the surface processor and the customer. This test shall be carried out by the method specified in [7.2.8](#), and the deterioration of the test specimens shall be evaluated by the change in appearance, gloss-retention and corrosion rate (RN). A recommended example of the outdoor exposure test and fastness are given in [Table A.2](#).

5.10 Hardness of the organic coating

The surface hardness of the electrophoretic organic coating shall be tested by the method specified in [7.2.9](#), and shall be evaluated by the degree of pencil hardness to be scratched. The hardness of the electrophoretic organic coating shall be more than 3 H in all classes.

5.11 Adhesion of the organic coating

The adhesion between the anodic oxidation coating and the electrophoretic organic coating shall be tested by the cross-cut test specified in [7.2.10.2](#) and the cross-cut test after immersion in boiling water specified in [7.2.10.3](#), and the performance shall be evaluated by the degree of exfoliation of the electrophoretic organic coating. The required adhesion of the organic coatings of all classes shall conform to [Table 2](#).

Table 2 — Required adhesion of the organic coating

Cross-cut test	Cross-cut test after immersion in boiling water	
Adhesion	Appearance	Adhesion
25/25	Without wrinkles, cracks and remarkable colour change on the significant surface	25/25

5.12 Solvent resistance of the organic coating

The solvent resistance of the electrophoretic organic coating shall be evaluated by using the method specified in [7.2.11](#). The change in hardness of the electrophoretic organic coating of all classes after the solvent resistance test shall be within $\Delta 1H$ without swellings, cracks and peeling on the significant surface.

5.13 Chemical resistance

If required by the customer, the chemical resistance of the combined coatings shall be tested.

This test shall be carried out with the alkali resistance test specified in [7.2.12.2](#) and/or the acid resistance test specified in [7.2.12.3](#), and evaluated by the appearance and corrosion rate (RN) of the test specimens. Recommended testing time and qualities of the combined coatings are given in A3.1 and/or A3.2.

In case of the combined coatings contact with mortar, the alkali resistance test should be implemented.

5.14 Abrasion resistance

If required by the customer, the abrasion resistance of the combined coatings shall be tested. The performance requirements should be agreed between the surface processor and the customer.

This test shall be carried out by the abrasive jet test specified in [7.2.13.2](#) or the falling sand abrasion test specified in [7.2.13.3](#), and the performance should be evaluated by the degree of abrasion as given in A.4.

The substitute test specimens shall be produced in the same way as the products, using the same semiproduct (i.e. sheet, profile), alloy and temper.

6 Test specimen

6.1 Sampling procedure

The test specimens shall be cut from the significant surfaces of the products. However, if they cannot be taken from production, substitute test specimens produced together with the real products may be used for testing. The sampling lot size should be agreed between the surface processor and the customer in accordance with ISO 2859-10, taking into consideration the kind of products, size and quantity.

6.2 Size of the test specimen

The size of test specimens should be chosen from the following sizes if there is no consensus:

150 mm x 70 mm, or 150 mm x 75 mm

6.3 Cleanliness of the test specimen

The surface of test specimens shall be wiped clean using soft wet cloths with deionized water or ethanol. Use deionized water if the coating can be attacked by ethanol.

7 Test

7.1 General condition

The temperature of the testing environment shall be room temperature and the relative humidity should be under 65 %. It shall be free from direct sunlight, gas, steam dust and wind, which all can influence the test results.

7.2 Test methods

7.2.1 Visual test

The visual test of the significant surface shall be carried out under artificial light or diffuse daylight specified in ISO 4628-1. The light source C (or D65) or high colour fidelity light (colour fidelity AAA) on the test specimens shall be over 600 lx. The distance and observing angle should be agreed between the surface processor and the customer. The background of the test specimens should be monochrome grey or black. The distance between the inspector and the test specimens should be 5 m when the inspection is done outdoors, and 3 m when it is indoors.

7.2.2 Inspection of colour

The inspection of colour and colour tolerance of the significant surface shall be carried out as specified in [7.2.1](#). The test specimens and standard specimen shall be placed on the same plane stand. Unless otherwise agreed between the surface processor and the customer, in the case of artificial light, the light source shall be placed behind the inspector and the test specimens shall always be observed at the same angle.

For the instrumental colour measurement, the surface processor and the customer should agree on the measurement condition, for example, the colourimetric system, the illuminant, the observation angle, the geometric light system.

7.2.3 Measurement of specular gloss

The measurement of the specular gloss shall be carried out in accordance with ISO 7668 (in the case of pigmented organic coatings, ISO 2813 is applied) at a 60° angle and the gloss-retention, G , expressed as a percentage, shall be calculated from the change of gloss caused by the exposure test, using Formula (1):

$$G = \frac{G_2}{G_1} \times 100 \quad (1)$$

where

G is the gloss-retention;

G_1 is the gloss at a 60° angle before exposure test;

G_2 is the gloss at a 60° angle after exposure test.

In the case that the inspected surface has a certain texture and the direction of measurement can affect the test result, the surface processor and the customer should agree upon the direction of measurement.

7.2.4 Measurement of anodic oxidation coating thickness

7.2.4.1 General

The thickness measurements of the anodic oxidation coating shall be carried out by the microscopical method specified in [7.2.4.2](#) or the eddy current method specified in [7.2.4.3](#).

In the case of dispute, the microscopical method shall be used for the reference test.

7.2.4.2 Microscopical method

The microscopical method shall be carried out in accordance with ISO 1463. Measure the anodic oxidation coating thickness at three points or more on the test specimen and round the mean to one decimal place and do it with the mean anodic oxidation coating thickness.

7.2.4.3 Eddy current method

The eddy current method shall be carried out in accordance with ISO 2360. Measure the anodic oxidation coating thickness at three points or more on the test specimen, calculate the average thickness and quote the result to one decimal place.

The thickness of anodic oxidation coating under organic coating may be measured after removing the organic coating using a suitable method that does not damage the anodic oxidation coating.

7.2.5 Corrosion resistance test

7.2.5.1 General

The corrosion resistance test shall be carried out using the AASS test or the CASS test in accordance with ISO 9227. The selection of the test method should be agreed between the surface processor and the customer. The corrosion rate (RN) may be assessed by the method specified in ISO 8993.

7.2.5.2 AASS test

Each test specimen shall be evaluated by determining the ratio of the area of corrosion pits to the area of the test specimen or the chart rating in accordance with ISO 8993. The result shall be converted to a rating number (RN) as shown in Table B. 1.

When calculating the ratio of the corrosion pits area, it is recommended to use a magnifying glass (10x to 15x magnification with scale).

When the test specimens in standard size are tested, it is permissible to evaluate the area of the test specimen except 25 mm from the top and bottom edges, and 10 mm from the right and left edges.

7.2.5.3 CASS test

Each test specimen shall be evaluated by determining the ratio of the area of corrosion pits to the area of the test specimen or the chart rating in accordance with ISO 8993. The result shall be converted to a rating number (RN) as shown in Table B. 1.

When calculating the ratio of the corrosion pits area, it is recommended to use a magnifying glass (10x to 15x magnification with scale).

When the test specimens in standard size are tested, it is permissible to evaluate the area of each test specimen except 25 mm from the top and bottom edges, and 10 mm from the right and left edges.

If copper is deposited on the surface of the test specimens, dissolve with dilute hydrochloric acid solution and followed by usual rinsing and drying.

7.2.6 Accelerated weathering test

7.2.6.1 General

The accelerated weathering test shall be carried out by the xenon-arc lamp exposure test or the open-flame carbon-arc exposure test. In the case of dispute, the xenon-arc lamp exposure test shall be the reference test.

7.2.6.2 Xenon-arc lamp exposure test

The xenon-arc lamp exposure test shall be carried out as follows:

- a) This test shall be carried out in accordance with ISO 11341 and testing time shall be adapted to [Table 1](#);
- b) The condition of wetting cycles, irradiance, black standard temperature (BST) or black panel temperature (BPT), and relative humidity during dry period shall be adapted to [Table 3](#);
- c) Evaluate the appearance of the test specimens specified in [7.2.1](#) after the exposure test;
- d) Then, the exposed test specimens shall be rinsed with deionized water and left for 1 h in the room for drying;
- e) Measure specular gloss of the test specimens specified in [7.2.3](#).

IMPORTANT 1 Except at the time of xenon-arc lamp exchange, filter exchange and cleaning of chamber, it is desirable not to stop the exposure test. When exchange and cleaning of parts, perform them in as short a time as possible.

IMPORTANT 2 Spray water shall be deionized and its conductivity shall be not higher than 2 µS/cm at 25 °C.

IMPORTANT 3 It is very important to adequately control the purity of spray water. If impurities, particularly silicates, are not removed from the water by proper treatment, exposed test specimens can develop spots or stains that are not representative of degradation occurring during outdoor exposure.

Table 3 — Test conditions of xenon-arc lamp exposure test

Item	Condition(s)
Radiation source and filter system	Xenon-arc lamp with daylight filters to method 1 in conformance with ISO 11341
Wetting cycles, min	Dry period:102
	Wetting period:18
Irradiance, W/m²	60 (between 300 nm and 400 nm)
Black standard temperature (BST) or Black panel temperature (BPT), °C	(65 ± 2) for BST(during dry period) (63 ± 2) for BPT(during dry period)
Relative humidity during dry period, %	40 to 60

7.2.6.3 Open-flame carbon-arc exposure test

The open-flame carbon-arc exposure test shall be carried out as follows:

- this test shall be carried out by the method in accordance with ISO 4892-4 and testing time shall be adapted to [Table1](#);
- the conditions of laboratory light source, spray cycle and black panel temperature (BPT) shall be adapted to [Table 4](#). The type of spray cycle, i.e. 1 or 2, shall be agreed between the surface processor and the customer;

Table 4 — Test conditions of open-flame carbon-arc exposure test

Item	Condition(s)
Laboratory light source	Open-flame carbon-arc lamp with extended-UV filters (type 3) in conformance with ISO 4892-4
Spray cycle, min	Spray cycle 1 Duration of spraying period: 12 ± 0,5 Dry interval between spraying period: 48 ± 0,5
	Spray cycle 2 Duration of spraying period: 18 ± 0,5 Dry interval between spraying period: 102 ± 0,5
Black panel temperature (BPT), °C	63 ± 3

- the same as 7.2.6.2 c);
- the same as 7.2. 6.2 d);
- the same as 7.2. 6.2 e).

IMPORTANT 1 Except at the time of carbon-arc lamp exchange, filter exchange and cleaning of chamber, it is desirable not to stop the exposure test. When exchange and cleaning of parts, perform them in as short a time as possible.

IMPORTANT 2 The same as [7.2.6.2](#), IMPORTANT 2.

IMPORTANT 3 The same as [7.2.6.2](#), IMPORTANT 3.

7.2.7 Cyclic corrosion/UV light test

For the procedure of the cyclic corrosion/UV light test, the AASS test or the CASS test shall be commenced within 30 min of the completion of the UV lamp exposure test. The UV lamp exposure test shall be carried out in accordance with ISO 11507. The conditions of lamps, light exposure (dry) period, condensation period, irradiance, black panel temperature (BPT) and chamber temperature shall be adapted to [Table 5](#).

Each test specimen shall be evaluated by determining the ratio of the area of corrosion pits to the area of the test specimen or the chart rating in accordance with ISO 8993. The result shall be converted to a rating number (RN) as shown in [Table B.1](#).

Table 5 — Test conditions of UV lamp exposure test

Item	Condition(s)
Lamps	UVB-313 lamps in conformance with ISO 11507
Light exposure (dry) period, h	4
Condensation period, h	4
Irradiance, W/m²	30 (for 270 nm to 700 nm)
Black panel temperature (BPT), °C	60 ± 3 (during dry period)
Chamber temperature, °C	50 ± 3 (during condensation period)

7.2.8 Outdoor exposure test

The natural weathering test shall be carried out in accordance with ISO 2810. The exposure site and duration time should be agreed between the surface processor and the customer.

The test specimens shall be exposed at a 45° angle facing the equator. An alternative exposure angle may be adopted if it is agreed by the surface processor and the customer. After the weathering exposure test, lightly clean the exposed test specimens with deionized water and then wipe with a soft cloth and dry. Do not remove any aged soft surface layers, such as chalk formation. Then, evaluate the exposed test specimens using the method specified in [7.2.1](#), [7.2.2](#) and [7.2.3](#).

An example of fastness to outdoor exposure test is given in [Table A.2](#).

The test site should be one specified place for the purpose of comparing durability of the test specimens based on the same condition. It is permitted to specify the common test site in each country or area, if there is comparative data about the aging among the test sites.

7.2.9 Hardness test by pencil method

The hardness test shall be carried out in an environment conforming to [7.1](#) using the test specimens left for 24 h or more after finishing. The hardness test of the electrophoretic organic coating shall be carried out with pencil hardness in accordance with ISO 15184.

Repeat the process five times at different points on the test specimen using the same hardness pencil. If there is no rupture of the outer coat of the combined coatings in not less than four of the five tests, quote the hardness scale of the pencil as the hardness of the combined coatings.

7.2.10 Adhesion test of the combined coatings

7.2.10.1 General

The adhesion test shall be carried out in an environment conforming to [7.1](#) using the test specimens left for 24 h or more after finishing. The adhesion shall be tested using the cross-cut test (see [7.2.10.2](#)) and the cross-cut test after immersion in boiling water (see [7.2.10.3](#)).

7.2.10.2 Cross-cut test

The cross-cut test shall be carried out in accordance with ISO 2409. Make six parallel cuts, which are 1 mm apart from each other, through the organic coating to the anodic oxidation coating and make similar cuts crossing at right angles to the first six cuts to make 25 squares.

Then stick adhesive tape, which is more than 25 mm wide and has an adhesive strength of between 6 N to 10 N per 25 mm width, on to the cut area of the test specimen, pressing down firmly with the finger to eliminate air bubbles under the tape. Then, pull the tape off perpendicular to the test specimen. When there is no coating removed, evaluate it as 25/25 (the number of divisions which did not come off by the total number of divisions).

7.2.10.3 Cross-cut test after immersion in boiling water

The boiling water immersion and cross-cut test is the test method to evaluate the visual change of the specimens caused by the boiling water as well as the resulting adhesion.

This test shall be carried out as follows.

- a) Pour deionized water into a vessel of approximately 150 mm depth to 80 mm depth and heat the vessel. Ensure the temperature of the water is over 95 °C; immerse the test specimens in the vessel at a 60 mm depth from the surface of the water.
- b) After immersion for 5 h, promptly remove the specimens and within 5 min evaluate the appearance of the significant surface for wrinkles, cracks and any noticeable colour change. Exclude from the evaluation the coating on the peripheral part of the specimens and parts that were within 10 mm of the surface of the water.
- c) If there was no defect, the cross-cut test specified in [7.2.10.2](#) shall be applied and it shall be evaluated. On the other hand, the specimen for which defects occurred on the significant surface shall be rejected.

7.2.11 Solvent resistance test

The solvent resistance test shall be carried out in an environment conforming to [7.1](#) using the test specimens left for 24 h or more after finishing. This test is the method to examine a change in the surface hardness of the electrophoretic organic coating before and after rubbing with a cotton wool containing xylene.

This test shall be carried out as follows:

- a) pencil hardness of the electrophoretic organic coatings shall be carried out specified in [7.2.9](#);
- b) repeat the process five times at different points on the test specimen using the same hardness pencil. If there is no rupture of the outer coat of the combined coatings in not less than four of the five tests, quote the hardness scale of the pencil as the hardness of the combined coatings;
- c) rub the test specimen softly using cotton wool impregnated with xylene over an area sufficient for subsequent evaluation. Use 30 reciprocal movements at a speed of one reciprocal movement in approximately one second;
- d) leave the test specimens for 30 min in the room;

- e) examine the hardness of the electrophoretic organic coating rubbed with xylene by a);
- f) evaluate solvent resistance by change of the surface hardness of the electrophoretic organic coating before and after the test.

WARNING — In the enforcement of this test, it is necessary that there be sufficient indoor ventilation.

7.2.12 Chemical resistance test

7.2.12.1 General

The chemical resistance test shall be carried out with the alkali resistance test specified in [7.2.12.2](#) and/or the acid resistance test specified in [7.2.12.3](#).

7.2.12.2 Alkali resistance test

The alkali resistance test is a method to examine the change of the combined coatings with sodium hydroxide solution.

This test shall be carried out as follows:

- a) apparatus: use materials which are not attacked by sodium hydroxide. Use a ring with an internal capacity of approximately 30 ml. A ring of 32 mm inside diameter and 30 mm in height is desirable;
- b) test solution: use a solution of 5 g/l sodium hydroxide in deionized water;
- c) let the ring adhere to the significant surface firmly and seal the outside part of the ring with petrolatum or paraffin;
- d) pour the test solution at a temperature of $20\text{ °C} \pm 2\text{ °C}$ to about half of the height of the ring and cover it with a glass or plastics;
- e) keep the test solution at $20\text{ °C} \pm 2\text{ °C}$. Recommended testing times are given in [Table A.3](#);
- f) remove the test solution and ring from the test specimen;
- g) clean the test specimen with deionized water and then leave it in the room for 1 h;
- h) draw a circle of 30 mm in diameter on the test specimen to be concentric with the position of the ring;
- i) evaluate etch pits and/or blisters occurring inside the circle by comparison with the RN charts in accordance with [Annex C](#).

In the case of measuring with a ruler without the RN charts, it is recommended to evaluate using a magnifying glass (10x to 15x magnification).

7.2.12.3 Acid resistance test (hydrochloric acid dropping test)

The acid resistance test shall be carried out with hydrochloric acid in accordance with AAMA 612-02:2002, 7.9. Apply 10 drops of 10 % (volume fraction) solution of muriatic acid (37 % commercial grade hydrochloric acid) in tap water and cover it with a watch glass, with the convex side up. The acid solution and the test shall be conducted at 18 °C to 27 °C . After a 15 min exposure, wash off with running water.

There should be no blistering and no change in appearance when examined by the unaided eye.

7.2.13 Abrasion resistance test

7.2.13.1 General

The abrasion resistance test is applicable where the product is exposed to the special environments of areas affected by dust storms. This test shall be carried out in an environment conforming to [7.1](#),

using the test specimens left for 24 h or more after finishing. The method and the degree of abrasion resistance should be chosen by agreement between the surface processor and the customer.

In the case of the abrasive jet test, if the layer of the anodic oxidation coating is too thin, the time taken to remove the coatings by abrasion is too short.

On the other hand, in case of the falling sand abrasion test, if the layer of the anodic oxidation coating is too thick, the time taken to remove the coatings by abrasion is too long. If too thin or too thick, they can both have an impact on the accuracy of the obtained test data.

Different results can arise from these abrasion resistance tests depending on impact resistance of the abrasive materials used.

For that reason, a standard specimen shall be made in accordance with ISO 8251 and used for both the abrasive jet and falling sand tests. The thickness of the anodic oxidation coating of the standard specimen shall be $10\ \mu\text{m} \pm 1\ \mu\text{m}$.

An example of abrasion resistance is given in [Table A.5](#).

7.2.13.2 Abrasive jet test

The abrasive jet test shall be carried out in accordance with ISO 8251.

7.2.13.3 Falling sand abrasion test

The falling sand abrasion test shall be carried out in accordance with ISO 8251.

The end point of the test shall be determined either by the electrical conductivity method or the spot diameter method in accordance with ISO 8251. The method should be chosen by agreement between the surface processor and the customer.

When a small black spot appears in the central part of the abraded area and enlarges to about 2 mm in diameter, terminate the test. The time taken for the test, in seconds, is the measurement for abrasion.

8 Expression of results

Document each test result, e.g. appearance, colour, gloss, thickness of anodic oxidation coating, corrosion resistance, resistance to accelerated weathering, resistance to cyclic corrosion/UV light, hardness of the electrophoretic organic coating, adhesion of the electrophoretic organic coating, solvent resistance.

If so required by the customer, document each test result for the outdoor exposure test, the chemical resistance test, and/or the abrasion resistance test.

9 Test report

The test report shall include at least the following information:

- a) a reference to this International Standard, i.e. ISO 28340:2013;
- b) the class and identification of the product tested;
- c) the results of the test (see [Clause 8](#));
- d) anything unusual noticed during the determination;
- e) the date of the test.

Annex A (informative)

Recommended characteristics and performance

A.1 Classes and applied environments

The relationship between class and applied environment is given in [Table A.1](#). This classification is only a guide.

Table A.1 — Classes and applied environments

Class	Environment to be used ^a
4	Outdoor in the area of severe environment with strong UV light exposure
3	Outdoor in the area of severe environment
2	Outdoor in the area of normal environment
1	Indoor
^a “Severe environment”: corrosive and degradative surrounding, such as an area polluted by sea salt; “area of strong UV light exposure”: tropical and subtropical area; “normal environment”: ordinary city, green area and industrial area.	

A.2 Fastness to outdoor exposure

Fastness to outdoor exposure of the combined coatings is given in [Table A.2](#).

Table A.2 — Fastness to outdoor exposure

Classes	Test period years	Appearance	Gloss retention %	Corrosion RN
4	5	No remarkable colour change and chalking	50 or more	9,0 or more
3	3			
2	1		—	—
1	—	—		

A.3 Chemical resistance

A.3.1 Alkali resistance

Alkali resistance of the combined coatings is given in [Table A.3](#).

Table A.3 — Alkali resistance

Class	Testing time h	Quality	
		Appearance	Degree of corrosion RN
4	24	Without swellings, cracks and peeling on the signifi- cant surface	9,5 or more
3	24		
2	24		
1	8		

A.3.2 Acid resistance

Acid resistance of the combined coatings is given in [Table A.4](#).

Table A.4 — Acid resistance

Class	Testing time min	Appearance
4	15	Without swellings, cracks and peeling on the significant surface
3		
2		
1		

A.4 Abrasion resistance

Example of abrasion resistance of the combined coatings is given in [Table A.5](#).

Table A.5 — Abrasion resistance

–	Jet abrasion test s	Falling sand abrasion test s
The area that is affected by the dust storm	35 or more	620 or more

Annex B (normative)

Rating number charts for evaluation of the corrosion rate

B.1 Rating number charts for evaluation of the corrosion rate of corrosion resistance test

[Table B.1](#) shows the conversion between chart rating in accordance with ISO 8993 and the percentage area of the significant surface covered by corrosion pits, and the associated rating number (RN).

Table B.1 — Corresponding rating numbers, chart ratings and percentage areas covered by corrosion pits

Rating number (RN)	Chart rating described in ISO 8993	Percentage area of corrosion pits
10	A	None
9,8	B1 B2 B3 B4 B5 B6	$\leq 0,02$
9,5	C1 C2 C3 C4 C5 C6	$> 0,02$ and $\leq 0,05$
9,3	D1 D2 D3 D4 D5 D6	$> 0,05$ and $\leq 0,07$
9	E1 E2 E3 E4 E5 E6	$> 0,07$ and $\leq 0,10$
8	F1 F2 F3 F4 F5 F6	$> 0,10$ and $\leq 0,25$

Annex C (normative)

Rating number charts for evaluation of the alkali resistance test

Rating number charts are given in [Figure C.1](#).

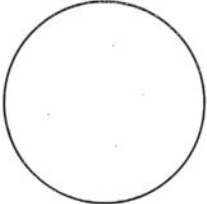
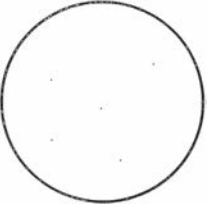
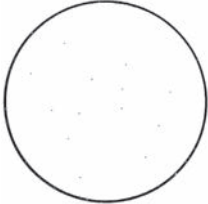
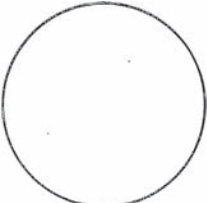
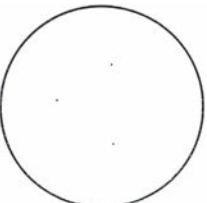
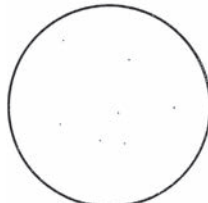
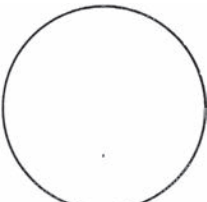
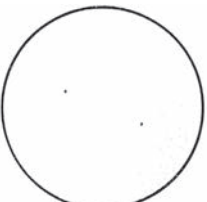
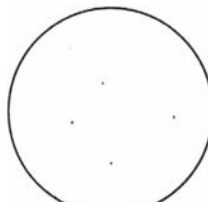
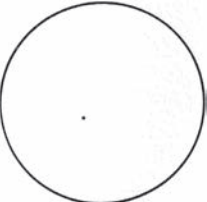
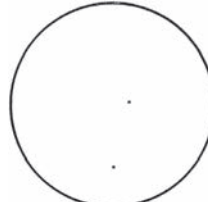
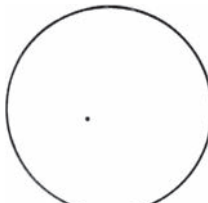
RN 9,8	RN 9,5	RN 9,3
		
		
		
		
		
Area of defects $\leq 0,02$ %	Area of defects $\leq 0,05$ %	Area of defects $\leq 0,07$ %

Figure C.1 — Rating number charts

Bibliography

- [1] ISO 2064, *Metallic and other inorganic coatings — Definitions and conventions concerning the measurement of thickness*
- [2] ISO 7583, *Anodizing of aluminium and its alloys — Terms and definitions*

