BS EN 13438:2013

BSI Standards Publication

Paints and varnishes — Powder organic coatings for hot dip galvanised or sherardised steel products for construction purposes

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National foreword

This British Standard is the UK implementation of EN 13438:2013. It supersedes BS EN 13438:2005 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee STI/27, Paint systems for metallic substrates.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Paints and varnishes - Powder organic coatings for hot dip galvanised or sherardised steel products for construction purposes

Peintures et vernis - Revêtements de poudre organique pour produits en acier galvanisé à chaud ou shérardisé utilisés dans la construction

Beschichtungsstoffe - Pulverbeschichtungen für feuerverzinkte oder sherardisierte Stahlerzeugnisse für Bauzwecke

This European Standard was approved by CEN on 19 July 2013.

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Contents

Page

Foreword

This document (EN 13438:2013) has been prepared by Technical Committee CEN/TC 139 “Paints and varnishes”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by March 2014, and conflicting national standards shall be withdrawn at the latest by March 2014.

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

This document supersedes EN 13438:2005.

In relation to EN 13438:2005, the following main amendments have been made:

a) the term defined as "test sample" has been removed;

b) a new term "substrate" has been introduced;

c) a paragraph in Clause 4 includes references to EN ISO 14713-2 and EN ISO 14713-3 to optimise design of articles sent for processing to this standard;

d) tolerance limits on gloss requirements has been tightened slightly for gloss levels over 50 units (reduced from ± 10 units to ± 7 units) and "Table 1 — Gloss requirements" removed;

e) Clause 6 has been edited to clarify references to "cleaning" as distinct from "preparation" or "pretreatment";

f) reference to (old) Table 1 in 6.5.5 "Gloss" has been removed;

g) an adhesion test on the finished powder coated article is now not mandatory (see revised 6.5.6) and if required should be specified;

h) a new "Table 1 — Summary of tests" has been included for ease of reference, after Clause 7;

i) the minimum thickness of coated test panels used for tests for mechanical properties has been increased from 0,3 mm to 1,0 mm (see A.3.1);

j) reference to updated standards have been included, e.g. replacement of ISO 7724-3 with EN ISO 11664-4 (see A.4.2) and replacement of ISO 1518 with EN ISO 1518-1 (see A.4.5);

k) Annex B has been edited to clarify references to "cleaning" and "pretreatment" and the content reduced;

l) the possibility of an adhesion test on finished article now included in Annex D (see D.3.5);

m) the content of Annex E has been reduced – reference has been made to EN 15773 for further information.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard has been produced as a result of the growing demand for products made of powder coated hot dip galvanised or sherardised steel. These products offer a combination of corrosion resistance and decorative appearance.

It is assumed in the drafting of this standard that the specified test methods will be applied by those who are suitably trained and supervised.

This European Standard has been written from a coating performance perspective and does not seek to set out one method of powder coating hot dip galvanised or sherardised steel products. Nevertheless, in order to facilitate production of the best quality powder coated hot dip galvanised or sherardised articles, experience has shown how important it is that sufficient dialogue between the client, specifier, designer, fabricator, galvaniser or sherardiser and powder coating applicator takes place at the earliest stages of the project and that, where possible, timescales set out for processing of the work are practical and adhered to.

It is strongly recommended that the guidance document for supply of duplex coatings, EN 15773, *Industrial application of powder organic coatings to hot dip galvanized or sherardized steel articles [duplex systems] — Specifications, recommendations and guidelines*, is used in combination with this standard when specifying for duplex systems.

1 Scope

This European Standard specifies performance requirements for organic coating powders and powder organic coatings as applied to finished articles (hot dip galvanised or sherardised steel products) for construction purposes. Hot dip galvanised steel products can be articles that have been batch hot dip galvanised (hot dip galvanised after fabrication) or articles consisting of continuously hot dip galvanised sheet which is then subsequently fabricated.

This European Standard does not set out any performance requirements for the powder coating process itself. Guidance on cleaning and pretreatment of the hot dip galvanised or sherardised steel products prior to powder coating is provided.

This European Standard does not apply to articles with zinc-aluminium coatings or aluminium-zinc coatings, or to continuously hot dip galvanised wire. This standard does not apply to organic coating powders and powder organic coatings as applied to hot dip galvanised or sherardised steel products (i.e. duplex coated articles) for which there are specific standards, which might include additional requirements or requirements which are different from those of this standard.

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.

EN 10346, *Continuously hot-dip coated steel flat products — Technical delivery conditions*

EN 13811, *Sherardizing — Zinc diffusion coatings on ferrous products — Specification*

EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods (ISO 1461)*

EN ISO 1518-1, *Paints and varnishes — Determination of scratch resistance — Part 1: Constant loading method (ISO 1518-1)*

EN ISO 1519, *Paints and varnishes — Bend test (cylindrical mandrel) (ISO 1519)*

EN ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method (ISO 2178)*

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

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

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

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

EN ISO 3231, *Paints and varnishes — Determination of resistance to humid atmospheres containing sulfur dioxide (ISO 3231)*

EN ISO 3668, *Paints and varnishes — Visual comparison of the colour of paints (ISO 3668)*

EN ISO 4618:2006, *Paints and varnishes — Terms and definitions (ISO 4618:2006)*

EN ISO 6270-1, *Paints and varnishes — Determination of resistance to humidity — Part 1: Continuous condensation (ISO 6270-1)*

EN ISO 8130-9, *Coating powders — Part 9: Sampling (ISO 8130-9)*

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

EN ISO 11341:2004, *Paints and varnishes — Artificial weathering and exposure to artificial radiation — Exposure to filtered xenon-arc radiation (ISO 11341:2004)*

EN ISO 11664-4, *Colorimetry — Part 4: CIE 1976 L*a*b Colour space (ISO 11664-4)*

ISO 10474, *Steel and steel products — Inspection documents*

3 Terms and definitions

For the purposes of this document, the terms and definitions contained in EN ISO 4618:2006 and the following apply.

3.1
finishing coat
final coat of a coating system

[SOURCE: EN ISO 4618:2006, 2.108]

3.2
conversion coating
layer produced on a hot dip galvanised or sherardised steel surface by a chemical treatment

3.3
powder coating
dry film obtained by application and fusing of a coating powder

3.4
coating powder
solvent-free coating material in powder form which, after fusing and possible curing, gives a continuous film

3.5
test piece
single item, representative of the work being processed

3.6
significant surface
part of the coated article on which the coating is essential for serviceability of the article

3.7
specifier
person specifying the performance requirements for the coating and significant surfaces of the article

3.8
coating applicator
company responsible for applying the coating powder onto a substrate

3.9
substrate
surface to which a coating material is applied or is to be applied

[SOURCE: EN ISO 4618:2006, 2.219]

4 Substrate material

The substrate shall be hot dip galvanised steel in accordance with EN ISO 1461, EN 10346, or sherardised steel in accordance with EN 13811. If required, steel sections shall be free from surface imperfections such as die lines and laminations. Unless otherwise agreed, the preparation of the surface of the hot dip galvanised article, such that the surface is suitable for pretreatment and application of powder to the surface, shall be the responsibility of the coating applicator (see 3.8).

The galvaniser or the sherardiser and coating applicator should be consulted about the design of the steel products intended for galvanising or sherardising after construction, prior to the fabrication stage, in order to optimise galvanising and powder coating quality.

NOTE EN 15773 and EN ISO 12944-4 provide some guidance on surface conditions that might be encountered on post fabrication hot dip galvanised or sherardised articles.

To achieve optimum quality of finished product, sharp edges on the fabrication should be avoided (see EN ISO 14713-2 and EN ISO 14713-3).

5 Coating powder

5.1 Identification

The following information shall be made available by the supplier for each consignment of coating powder:

a) manufacturer;

b) trade name;

c) colour;

d) gloss level;

e) type of resin;

f) batch number;

g) box number;

h) product reference code;

i) date of manufacture;

j) date of despatch.

5.2 Storage

The coating powder, after storage in unopened containers for a maximum period indicated by the manufacturer, calculated from the date of dispatch by the manufacturer, shall still conform to 5.3. If no maximum permissible storage period is indicated by the manufacturer, the coating powder shall, after storage in unopened containers for up to 12 months from the date of despatch by the manufacturer, conform to 5.3.

The storage temperature shall not exceed 25 °C unless otherwise specified by the coating powder manufacturer.

Coating powder that has been stored for longer than the maximum permissible period indicated by the manufacturer (or if no maximum permissible storage period has been indicated and the coating powder has been stored for longer than 12 months) shall only be used upon agreement between the manufacturer and the coating applicator.

5.3 Performance requirements

5.3.1 General

The following requirements (5.3.2. to 5.3.12) shall be met. Tests shall be carried out in accordance with Annex A by the manufacturer of the coating powder.

The manufacturer of the coating powder shall identify, with reference to Class 1 or Class 2, the performance capability of powder supplied, dependent upon the results of testing set out in 5.3.12.

5.3.2 Colour

When a coated test panel is examined in accordance with A.4.2, the colour of the coating shall be within the tolerance limits indicated by the manufacturer.

5.3.3 Gloss

When a coated test panel is examined in accordance with A.4.3, the gloss level of the coating shall be within the tolerance limits indicated by the manufacturer. If no tolerance limits have been indicated by the manufacturer, the tolerance limits on the gloss level of the coating shall be $\pm$ 7 units.

5.3.4 Adhesion

When a coated test panel is tested in accordance with A.4.4, the result shall be in accordance with the classification 0 of EN ISO 2409.

5.3.5 Resistance to scratching

When a coated test panel is tested in accordance with A.4.5, there shall be no penetration through the coating to the substrate.

5.3.6 Resistance to deformation

When a coated test panel is tested in accordance with A.4.6, there shall be no cracking or delamination of the coating from the substrate.

5.3.7 Resistance to mortar

When a coated test panel is tested in accordance with A.4.7, the mortar shall be readily dislodged without the use of an implement. There shall be no detachment of the coating and no change in its appearance.

5.3.8 Resistance to weathering

A coated test panel shall conform to one of the following weathering tests, dependent on the product and following the agreement between the coating applicator and the specifier.

a) Resistance to artificial weathering: After testing in accordance with A.4.8.1, there shall be no signs of cracking or blistering. The residual gloss level shall be more than 40 % of the original gloss level. Colour changes shall be within the limits agreed by the coating applicator and the specifier (e.g. as ΔE and/or ΔC and/or ΔL).

b) Resistance to natural weathering: After testing in accordance with A.4.8.2, there shall be no signs of cracking, blistering or unacceptable colour change.

NOTE Natural weathering tests are generally considered to be more informative than artificial weathering procedures in assessing coating durability, but necessarily take longer.

5.3.9 Resistance to humidity

When a coated test panel is tested in accordance with A.4.9.1 there shall be no blistering, softening or detachment of the coating, nor signs of corrosion of the substrate.

When the coating is tested by the method described in A.4.9.2 the result shall be in accordance with the classification 0 of EN ISO 2409.

5.3.10 Resistance to sulfur dioxide

When a coated test panel is tested in accordance with A.4.10, there shall be no colour change in comparison with an unexposed coated test panel, no blistering of the coating and no signs of corrosion of the substrate.

5.3.11 Permeability

When a coated test panel is tested in accordance with A.4.11, there shall be no blistering or detachment of the coating. Any blistering within 3 mm of any panel edge shall be ignored.

5.3.12 Resistance to salt spray

5.3.12.1 General

Coating powders shall be subject to the following tests. Coated test panels shall be subjected to one of the two tests, as referred to in 5.3.12.2 or 5.3.12.3, and powders which pass shall be designated by the appropriate "class" by the powder supplier.

5.3.12.2 Neutral salt spray

When tested in accordance with A.4.12.1, there shall be no underfilm corrosion or loss of adhesion extending in a perpendicular direction beyond 5 mm from the scribed lines and there shall be no signs of blistering or cracking on any other part of the panel. Powders which pass this test shall be designated "Class 1" by the powder supplier.

5.3.12.3 Acetic acid salt spray

When tested in accordance with A.4.12.2, there shall be no underfilm corrosion or loss of adhesion extending in a perpendicular direction beyond 5 mm from the scribed lines and there shall be no signs of blistering or cracking on any other part of the panel. Powders which pass this test shall be designated "Class 2" by the powder supplier.

5.4 Health and safety information

Relevant information on the chemical and physical characteristics, storage and use of the organic powders shall be provided by the coating powder supplier to the coating applicator.

6 Application

6.1 Cleaning and pretreatment of the hot dip galvanised or sherardised substrate

Guidance on cleaning and pretreatment is given in Annex B.

6.2 Coating powder

Coating powders shall conform to Clause 5.

6.3 Application of coating powder

The coating powder manufacturer shall provide information to the coating applicator regarding the recommended conditions of application of the powder coating. Guidance on the application of the powder coating is given in Annex C.

6.4 Significant surfaces of coated article

Significant surfaces shall be indicated by the specifier.

6.5 Performance requirements of the powder coated article

6.5.1 General

The requirements in 6.5.2 to 6.5.5 (and 6.5.6 where specified) shall be met. The tests in 6.5.2 to 6.5.5 (and 6.5.6 where specified) shall be carried out by the coating applicator.

The surface finish and surface chemistry of the steel can influence the structure and surface finish of the hot dip galvanised coatings formed. Variations in surface smoothness of the hot dip galvanised coatings allowed for in the supply standard (e.g. EN ISO 1461) should be taken into account when assessing the surface smoothness of finished article (see EN 15773 and EN ISO 14713-2 for additional information).

NOTE The electrostatic deposition of a coating powder can cause thicker coatings near edges and thinner coatings in recesses.

6.5.2 Surface appearance

When tested in accordance with D.3.1, the coating on significant surfaces shall show no scratches through to the substrate. No blisters, craters or scratches shall be first visible from a distance of not less than 3 m.

A slight degree of orange peel can sometimes occur. Before any work is conducted, the maximum extent of orange peel allowable should be obtained from the specifier, using suitable reference samples where agreed. Pinholing and variations in characteristics (such as colour and gloss) can be reduced by avoiding large changes in the section thickness of materials in the same fabrication, as these materials will exhibit significant differences in heat capacity.

6.5.3 Colour

When tested in accordance with D.3.2, the coating on significant surfaces shall match the reference colour previously nominated by the coating powder manufacturer.

6.5.4 Thickness

When tested in accordance with D.3.3, the thickness of the coating on significant surfaces shall be within the range specified by the coating powder manufacturer, and not less than 60 μm. The substrate shall not be visible at any edge.

6.5.5 Gloss

When tested in accordance with D.3.4, the gloss level on significant surfaces shall be within the range specified by the coating powder manufacturer or where no tolerance limits have been indicated by the manufacturer the tolerance limits on the gloss level of the coating shall be ± 7 units.

6.5.6 Adhesion

Where specified test for adhesion in accordance with D.3.5, the coating shall meet classification 0 of that standard.

7 Certificate of conformity

The coating applicator shall, on request, issue a certificate of conformity in accordance with ISO 10474.

Table 1 sets out a summary of the relevant tests referenced in the above clauses for information.

Table 1 — Summary of tests

Tests for coating powders to be carried out by the coating powder manufacturer			
Clause	**Test**	**Test method / standard**	**Summary of requirement**
General	Surface appearance	EN ISO 3668	No scratches through to substrate. No blisters, craters, pinholes or scratches first visible from < 1 m.
5.3.2 / A.4.2	Colour	EN ISO 3668 / EN ISO 11664-4	Within tolerances.
5.3.3 / A.4.3	Gloss	EN ISO 2813	Within tolerances.
5.3.4 / A.4.4	Adhesion	EN ISO 2409	Classification 0.
5.3.5 / A.4.5	Scratch resistance	EN ISO 1518-1	No penetration through to substrate.
5.3.6 / A.4.6	Deformation resistance	EN ISO 1519	No cracking or delamination.
5.3.7 / A.4.7	Mortar resistance	Procedure described	Mortar dislodged easily. No detachment of coating or change in appearance.
5.3.8.a / A.4.8.1	Weathering (artificial)	EN ISO 11341	No cracking or blistering. Residual gloss level > 40 % of original. Colour changes within tolerances.
5.3.8.b / A.4.8.2	Weathering (natural)	EN ISO 2810	No cracking or blistering. No unacceptable colour change.
5.3.9 / A.4.9	Humidity	EN ISO 6270-1 / EN ISO 2409	No blistering, softening or detachment of the coating. No corrosion. Classification 0.
5.3.10 / A.4.10	Sulfur dioxide	EN ISO 3231	No blistering of the coating or corrosion of the substrate. No colour change.
5.3.11 / A.4.11	Permeability	Procedure described	No blistering or detachment of the coating.
5.3.12.2 / A.4.12.1	Neutral salt spray	EN ISO 9227	No under-film corrosion or loss of adhesion beyond 5 mm from scribe lines. No blistering or cracking on rest of panel.
5.3.12.3 / A.4.12.2	Acetic acid salt spray	EN ISO 9227	No under-film corrosion or loss of adhesion beyond 5 mm from scribe lines. No blistering or cracking on rest of panel.

Table 1 *(continued)*

Tests for powder coatings to carried out by the coating powder applicator			
Clause	**Test**	**Test method / standard**	**Summary of requirement**
6.5.2 / D.3.1	Surface appearance	EN ISO 3668	No scratches through to substrate. No blisters, scratches or craters first visible from < 3 m.
6.5.3 / D.3.2	Colour	EN ISO 3668	Match colour specified.
6.5.4 / D.3.3	Thickness	EN ISO 2808	For significant surfaces – within range specified by manufacturer and not less than 60 μm. Substrate not visible at edges.
6.5.5 / D.3.4	Gloss	EN ISO 2813	Within range specified.
6.5.6 / D.3.5 (where specified) / D.4	Adhesion	EN ISO 2409	Classification 0.

Annex A
(normative)

Methods of test for coating powders

A.1 General

Unless otherwise specified, carry out the tests in duplicate (see A.3.1).

A.2 Sampling

Take a representative sample of the coating powder in accordance with EN ISO 8130-9.

A.3 Coated test panels

A.3.1 Material and dimensions

Hot dip galvanised test panels (for tests not related to mechanical properties) shall be rectangular, 150 mm × 100 mm in area, of steel thickness in the range 0,75 mm to 1,6 mm and meet the requirements of grade Z275-N-A of EN 10346. Hot dip galvanised test panels for mechanical properties shall have a steel thickness of not less than 1,0 mm.

Sherardised test panels (for tests not related to mechanical properties) shall be rectangular, 150 mm × 100 mm in area, of steel thickness in the range 0,75 mm to 1,6 mm and meet the requirements of EN 13811, Class 30. Sherardised test panels for mechanical properties shall have a steel thickness of not less than 1,0 mm.

Additional test panels may also be agreed between parties, for instance incorporating thicker steel.

A.3.2 Pretreatment

Pretreatment of the test panels should be in accordance with 6.1.

A.3.3 Coating of the test panels

The test panels shall be coated with the coating powder in accordance with the manufacturer's recommendations to give a powder coating thickness of not less than 60 μm when determined by one of the procedures specified in EN ISO 2808.

A.3.4 Determination of thickness

A.3.4.1 General

In order to facilitate the accurate measurement of the thickness of the powder coating, predetermine the thickness of the hot dip galvanised or sherardised coating. Use a suitable template to locate the measurement position on the test panel. Measure both the hot dip galvanising or sherardised coating thickness and the thickness of the total coating in exactly the same location. Determine the thickness of the powder coating over the hot dip galvanised or sherardised substrate by difference. Alternatively, where equipment is available that can, without being moved from the original chosen spot on the surface of the coated article, differentiate

between the thickness of the hot dip galvanised or sherardised coatings and the thickness of the powder coatings, this may then be used.

NOTE 1 As a result of the nature of the steel surface chemistry and the process of hot dip galvanising, the galvanising coating thickness on articles hot dip galvanised after fabrication can vary over relatively small areas (e.g. a few square millimetres).

NOTE 2 This effect is less pronounced for sherardised coatings, since the sherardising process is based upon solid diffusion in which the coating thickness is more or less equal on all parts of the article and follows the contours and shape of the article.

A.3.4.2 Hot dip galvanised or sherardised coating thickness

Identify, without damaging the galvanising or sherardising, two positions on the uncoated test piece. The positions shall be approximately 50 mm and 100 mm from one end and shall lie approximately on the centre line of the test panel. Determine the thickness of the hot dip galvanised or sherardised coating in accordance with EN ISO 2178 and record the readings together with the locations.

A.3.4.3 Thickness of the powder coating

The thickness of the total coating shall be determined using the same instrument and at the same locations as identified in A.3.4.2. Alternatively, where equipment is available that can, without being moved from the original chosen spot on the surface of the coated article, differentiate between the thickness of the hot dip galvanised or sherardised coatings and the thickness of the powder coatings, this may then be used.

A.3.5 Appearance and conditioning

The finishing coat shall be free from the surface defects specified in A.4.1. Condition the test panels at (23 $\pm$ 2) °C for a minimum 1 h, before carrying out the specified tests.

A.4 Test procedures on coated test panels

A.4.1 Surface

Illuminate the surface of the test piece in accordance with EN ISO 3668 and examine at an oblique angle with normal corrected vision.

The coating powder, when applied to a prepared test panel in accordance with Annex A shall show no scratches through to the substrate. When a coated test panel is examined no blisters, craters, pinholes or scratches shall be first visible from a distance of 1 m.

A.4.2 Colour

Examine the surface of the test piece visually in accordance with EN ISO 3668 or colorimetrically in accordance with EN ISO 11664-4 and check for colour match.

A.4.3 Gloss

Examine the surface of the test piece in accordance with EN ISO 2813, using an angle of incidence of 60° to the normal to the surface of the coating and determine the gloss level.

A.4.4 Adhesion

Determine the adhesion of the coating in accordance with EN ISO 2409.

A.4.5 Resistance to scratching

Determine the scratch resistance of the coating in accordance with EN ISO 1518-1, using a load of 20 N on a scratch stylus A having a hemispherical hard-metal tip of radius (0,50 ± 0,01) mm.

A.4.6 Resistance to deformation

Determine the resistance to deformation in accordance with EN ISO 1519, using a 16 mm diameter mandrel and a test panel prepared in accordance with A.3.

A.4.7 Resistance to mortar

A.4.7.1 Principle

A pat of wet cement-lime-sand mortar is applied to the dry coating and the surface of the coating is assessed after allowing the mortar to dry and set.

A.4.7.2 Procedure

Prepare a mortar by mixing 15 g of hydrated lime, 41 g of cement and 244 g of sand with sufficient tap water to make a soft paste. Apply four portions of this mortar, approximately 15 mm in diameter and approximately 6 mm thick, to the coating on the test panel.

Store the panel horizontally at (38 ± 3) °C and (95 ± 5) % relative humidity for 24 h.

At the end of this period, dislodge the mortar by hand from the surface of the coating and remove any residue with a damp cloth. Allow to dry and examine the coating with normal corrected vision, to determine incidences of detachment of the coating or changes in appearance due to the effect and removal of the mortar.

A.4.8 Resistance to weathering

A.4.8.1 Artificial weathering

Determine the resistance to artificial weathering in accordance with EN ISO 11341, using a test period of 1 000 h and an irradiance of 550 W/m^2, in the spectral range 290 nm $\leq \lambda \leq$ 800 nm, with the spectral energy distribution as given in Table 1 of EN ISO 11341:2004, a black standard temperature of (65 ± 2) °C and a wetting cycle of 102 min/18 min.

A.4.8.2 Natural weathering

Determine the resistance to natural weathering in accordance with EN ISO 2810. Expose coated test panels for a period of 12 months at an angle of 5° to the horizontal, facing south, starting in April, at a weathering site in Florida which shall be at least 5 km from the sea.

Wash the test panels prior to inspection with water containing 1 % of a neutral detergent, using a sponge and taking care to avoid polishing. Afterwards rinse the panels with deionised water, having a maximum electrical conductivity of 1 μS/cm.

A.4.9 Resistance to humidity

A.4.9.1 General

Test a coated test panel for resistance to humidity in accordance with EN ISO 6270-1, using a test period of 1 000 h, and evaluate for blistering, softening or detachment of the coating or signs of corrosion of the substrate.

A.4.9.2 Cross-cut test

Dry the panel with absorbent paper and leave for 24 h at (23 ± 2) °C. Conduct a cross-cut test in accordance with EN ISO 2409.

A.4.10 Resistance to sulfur dioxide

Test a coated test panel for resistance to sulfur dioxide in accordance with EN ISO 3231, using 0,2 l of sulfur dioxide and with a test duration of ten cycles.

A.4.11 Permeability

Add deionised water, having a maximum conductivity of 30 μS/cm at 20 °C to a pressure cooker to give a depth of (25 ± 3) mm. Partially immerse the coated test panel in the water so that a minimum length of 25 mm is immersed and secure the lid of the pressure cooker.

Apply heat to the pressure cooker until steam is emitted from the valve. Insert a weighted needle valve to give a pressure of 100 kPa and continue heating for 2 h from the time the steam was first emitted.

Cool the apparatus with care.

Remove the test panel and allow it to cool to ambient temperature. Examine the test piece for signs of blistering.

A.4.12 Resistance to salt spray

A.4.12.1 Neutral salt spray

In the middle of the test panel, scribe a cross to expose, but not penetrate, the substrate. The cross shall be a rectangular cross in which each of the diagonals has a length of 50 mm, the intersection is centred in the middle of the panel and the scribe lines intersect at 90º. Place the coated test piece in a spray cabinet conforming to EN ISO 9227 (NSS test) and expose to salt spray for a continuous period of 750 h. At the end of the test, remove the sample carefully from the test cabinet, wash the test panels in deionised water at a temperature of less than 35 °C, and immediately dry. Attempt to lift the coating from the scribed line with a sharp tool. Examine the area around the scribed cross.

A.4.12.2 Acetic acid salt spray

Determine the resistance of a coated test panel in accordance with EN ISO 9227, Acetic Acid Salt Spray (AASS) test. In the middle of the test panel, scribe a cross to expose, but not penetrate, the substrate. The cross shall be a rectangular cross in which each of the diagonals has a length of 50 mm the intersection is centred in the middle of the panel and the scribe lines intersect at 90º. Place the coated test piece in a spray cabinet conforming to EN ISO 9227 (AASS test) and expose to salt spray for a continuous period of 480 h. At the end of the test, remove the sample carefully from the test cabinet, wash the test panels in deionised water at a temperature of less than 35 °C, and immediately dry. Attempt to lift the coating from the scribed line with a sharp tool. Examine the area around the scribed cross.

Annex B
(informative)

Guidance on cleaning and pretreatment processes

B.1 Cleaning

The objective of the cleaning is to effect the removal of any surface contamination from the hot dip galvanised or sherardised coating and promote satisfactory adhesion of the subsequently applied powder coating.

Therefore, prior to pretreatment (unless the hot dip galvanised or sherardised coating is already clean and free from surface contamination and/or zinc corrosion products), the substrate should be thoroughly cleaned and rinsed. This cleaning action usually consists of application of an alkaline or acidic solution to the hot dip galvanised or sherardised surface to remove all traces of oil, grease, lubricants and other residues (including zinc corrosion products, e.g. zinc oxide, zinc hydroxide and zinc carbonate) that might have contaminated the surface.

Continuously hot dip galvanised surfaces might have a layer of temporary corrosion protection which should be removed prior to subsequent application of a powder organic coating.

B.2 Pretreatment

Pretreatment of the cleaned hot dip galvanised or sherardised surface should take place by chemical processing, or mechanical processing, or a combination of the two (mechanical processing should take place prior to chemical processing). Alternative pretreatments might exist which can provide adequate pretreatment of the substrate material to enable compliance with this standard.

The sequence of steps in one typical pretreatment process is set out in Table B.1. Alternative procedures may be used provided that the requirements of this standard are met.

Pretreatment stages should take place one after the other with the minimum delay in between to ensure that the surface to be pre-treated does not become dry between successive stages.

The pretreatment solution should be applied by either:

a) dipping in baths of sufficient size to allow the chemical conversion process to proceed appropriately on all significant surfaces; or

b) spraying in tanks or cabinets constructed so that the chemical conversion reaction takes place on all significant surfaces for the required time.

NOTE Sherardised substrates are normally supplied with a zinc phosphate or zinc chromate conversion coating applied.

B.3 Types of pretreatment

B.3.1 Conversion and drying of the conversion coating (chemical pretreatment)

Unless otherwise specified, a conversion coating should be applied. Prior to the application of the powder coating the surfaces should be free from dust, grease or powdery deposits.

Where a chemical conversion coating is used, the coating should be applied, with a chromate process a phosphate process, a silane / zirconium-based process, or suitable alternative.

The conversion coating should be thoroughly dried before the application of the powder coating. The recommendations from the chemical supplier should be followed when drying the conversion-coated article. Drying is an essential procedure since it minimises the quantity of retained surface water that might subsequently be evolved at the curing stage of the powder coating.

Table B.1 — Example of a pretreatment process prior to powder coating of a hot dip galvanised or sherardised substrate

Order of process steps	Process
1	Degrease in an alkaline or acidic water-based solution
2	Rinse in cold tap water (may be repeated)
3	Acid etch (dilute solution)
4	Rinse in cold tap water (may be repeated)
5	Chemical conversion coating, e.g. chromating, phosphating silane / zirconium-based processes or suitable alternatives
6	Rinse in water (may be repeated)
7	Rinse in deionised water (may be repeated)
8	Thermal treatment (including thorough drying of the substrate), following the chemical suppliers recommendations
9	Powder coating (e.g. in spray booths)

Additional information regarding the process of powder coating of the pre-treated hot dip galvanised articles is given in Annex C.

For sherardised articles, a phosphate pretreatment is recommended.

B.3.2 Mechanical pretreatment

The surface of the hot dip galvanised or sherardised components may be sweep blast-cleaned to provide improved adhesion to the subsequently applied powder coating. This procedure should be carried out in such a way that the hot dip galvanised or sherardised surface does not show signs of mechanical failure (flaked or detached hot dip galvanised coatings).

A sweep blast-cleaning abrasive medium should be used, such as carborundum or aluminium oxide, with a blasting pressure not greater than 300 kPa. The residual hot dip galvanised coating should, after pretreatment using this method, still meet the supply specification with regard to coating thickness/weight per unit area.

Ideal nozzle-to-component surface distances will vary according to the geometry of the component. Trials should be undertaken to establish best practice.

This method of pretreatment may be used on its own or in combination with a subsequent application of a conversion coating. Where this method is used prior to conversion coating, it is essential that the surface of the sweep blasted coating is free from dust, oil and grease.

Mechanical pretreatments may be applied to continuously hot dip galvanised substrates. This type of pretreatment process, if it is not controlled properly, can remove a significant proportion of the hot dip galvanised coating present on continuously hot dip galvanised product.

Annex C
(informative)

Guidelines on the powder coating process

Guidance given below on powder coating processes is not intended to be exhaustive. Alternative methods of powder coating might be available which produce powder coated articles that satisfy the requirements of this standard.

Appropriate thermal treatment of the articles prior to and/or during coating is critical to the achievement of adequately bonded and cured powder coating to the substrate and to minimise the potential for pin-holing to occur.

Table C.1 briefly illustrates one method of powder coating in common use throughout Europe.

Table C.1 — Example of a powder coating process for hot dip galvanised or sherardised components

Order of process steps	Process
1	Components supplied are in the following state: degreased, chemically converted surfaces or sweep blast-cleaned, dry and free from contamination (see Annex B)
2	Coating powder applied according to the manufacturer instructions, e.g. in a spray booth
3	Components stoved at the recommended temperature for the specified time period (see coating powder suppliers instructions)
4	Components air-cooled
5	Inspection and testing of finished product
6	Storage and packing (see Annex E)

Annex D
(normative)

Methods of test for powder coatings

D.1 General

Coating tests shall be carried out in duplicate in accordance with this annex.

Additional test pieces, supplied by the specifier, may be used subject to agreement between the specifier and coating applicator.

D.2 Test piece preparation

Hot dip galvanised test pieces (for tests not related to mechanical properties) shall be rectangular, 150 mm × 100 mm in area, of steel thickness in the range 0,75 mm to 1,6 mm and meet the requirements of grade Z275-N-A of EN 10346. Hot dip galvanised test panels for mechanical properties shall have a steel thickness of not less than 1,0 mm.

Sherardised test pieces (for tests not related to mechanical properties) shall be rectangular, 150 mm × 100 mm in area, of steel thickness in the range 0,75 mm to 1,6 mm and meet the requirements of EN 13811, Class 30. Sherardised test panels for mechanical properties shall have a steel thickness of not less than 1,0 mm.

Additional test panels may also be agreed between parties, for instance incorporating thicker steel.

D.3 Test procedures on finished articles

D.3.1 Surface appearance

Illuminate the significant surfaces in accordance with EN ISO 3668 and examine at an oblique angle with normal corrected vision.

D.3.2 Colour

Test in accordance with EN ISO 3668 and examine significant surfaces for colour match.

D.3.3 Thickness

Determine the total thickness of the coating on each significant surface in accordance with EN ISO 2808 with a minimum of five determinations. Inspect the edges for visibility of substrate.

D.3.4 Gloss

Determine the gloss level according to EN ISO 2813 when assessed at an angle of incidence of 60º.

D.3.5 Adhesion

Determine the adhesion level according to EN ISO 2409.

D.4 Test procedures on test panels

Prepare test panels in accordance with D.2.

Carry out the cross-cut test, in duplicate, in accordance with EN ISO 2409.

Annex E
(informative)

Guidelines on the care and protection of powder coated hot dip galvanised or sherardised steel components

E.1 Packing and handling

Powder coated hot dip galvanised or sherardised steel components should be handled, packed and transported carefully to avoid being damaged or contaminated (see also EN 15773). It is recommended that an appropriate note to this effect is affixed to each lot or bundle in a consignment. This note should state that care should be taken when handling and particularly when unloading these components. Powder coated products should be individually packed, e.g. in plastic sleeving (with adequate ventilation holes), and additional protection given at corners. Where possible, recyclable materials should be used for protection purposes. Additional care should be taken when materials are handled at low temperatures.

E.2 Tapes

It is recommended that protective tapes, unless of the "low tack" variety, should not be utilised as some of these materials can adversely affect the properties of the finishing coat. If the use of such tape for on-site protection is required, the tapes should be specifically designed for the protection of the finishing coat. Also, if they are to be used, these materials should be approved by the specifier with the agreement of the coating applicator.

NOTE EN 15773 will be subject to update and many aspects of care for powder coated hot dip galvanised or sherardised products will be addressed within its contents.

Bibliography

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[3] EN ISO 14713-2, *Zinc coatings — Guidelines and recommendations for the protection against corrosion of iron and steel in structures —Part 2: Hot dip galvanizing (ISO 14713-2)*

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