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Fourth edition
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Metallic and other inorganic coatings — Electroplated coatings of zinc with supplementary treatments on iron or steel

Revêtements métalliques et autres revêtements inorganiques — Dépôts électrolytiques de zinc avec traitements supplémentaires sur fer ou acier

Reference number
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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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

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

This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 262, *Metallic and other inorganic coatings*, in collaboration with ISO Technical Committee TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 3, *Electrodeposited coatings and related finishes*, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 2081:2008), which has been technically revised. The following main changes have been made:

— the number of normative references has been reduced;

— reference to ASTM B117 has been replaced with ISO 9227;

— some abbreviated terms have been removed;

— coating designations have been modified;

— reference to ISO 1463 for thickness measurement has been increased;

— reference to use of trivalent chromium has been increased

— reference to use of hexavalent chromium has been reduced;

— reference to ISO 19598 in relation to supplementary Cr(VI)-free treatment has been added;

— Tables 1 and 2 have been replaced with a revised Table 1 on neutral salt spray corrosion resistance;

— reference to ISO 15330 in relation to hydrogen embrittlement testing has been added;

— supplementary treatment designations have been modified;

— Annex C has been removed.

Introduction

Zinc coatings are applied to iron or steel articles for protective and decorative purposes by electrodeposition from acid zinc chloride, alkaline non-cyanide zinc, and alkaline zinc cyanide solutions. Electroplated, bright zinc coatings are popular and the processes for preparing bright zinc coatings are widely used.

The ability of a zinc coating to prevent corrosion is a function of its thickness and the type of service conditions to which it is exposed. For example, the rate of corrosion of zinc will generally be greater in industrial exposures than in rural ones. The type of service condition should, therefore, be taken into consideration when specifying the minimum coating thickness. Trivalent chromate conversion coatings and other supplementary treatments enhance the corrosion resistance of electrodeposited zinc coatings and are commonly applied after electroplating.

Because the appearance and serviceability of zinc coatings depends on the surface condition of the basis metal, agreement should be reached between the interested parties that the surface finish of the basis metal is satisfactory for electroplating.

Trivalent chromate conversion coatings are omitted, or replaced by other conversion coatings, at the specific request of the purchaser. This document provides the codes for all types of chromate conversion and other supplementary coatings.

With reference to Cr(VI)-free conversion coatings, attention is drawn to ISO 19598. ISO 19598 is applicable to zinc, zinc-iron and zinc-nickel plating, where only trivalent systems are required.

Due to the REACH Regulations the use of hexavalent chromium compounds will be banned in Europe from September 2017 except where specifically authorized. Alternative conversion coatings or substitutes, can be used and are required to satisfy the corrosion requirements given in this document.

Standard designations for metals and alloys can be found in References [12] to [16].

Metallic and other inorganic coatings — Electroplated coatings of zinc with supplementary treatments on iron or steel

WARNING — This document calls for the use of substances and/or procedures that can be injurious to health if adequate safety measures are not taken. This document does not address any health hazards, safety or environmental matters associated with its use. It is the responsibility of the producers, purchasers and/or user of this document to establish appropriate health, safety and environmentally acceptable practices.

1 Scope

This document specifies requirements for electroplated coatings of zinc with supplementary treatments on iron or steel. It includes information to be supplied by the purchaser to the electroplater, and the requirements for heat treatment before and after electroplating.

It is not applicable to zinc coatings applied

— to sheet, strip or wire in the non-fabricated form,

— to close-coiled springs, or

— for purposes other than protective or decorative.

This document does not specify requirements for the surface condition of the basis metal prior to electroplating with zinc. However, defects in the surface of the basis metal can adversely affect the appearance and performance of the coating.

The coating thickness that can be applied to threaded components can be limited by dimensional requirements, including class or fit.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 2064, *Metallic and other inorganic coatings — Definitions and conventions concerning the measurement of thickness*

ISO 2080, *Metallic and other inorganic coatings — Surface treatment, metallic and other inorganic coatings — Vocabulary*

ISO 2819, *Metallic coatings on metallic substrates — Electrodeposited and chemically deposited coatings — Review of methods available for testing adhesion*

ISO 3613, *Metallic and other inorganic coatings — Chromate conversion coatings on zinc, cadmium, aluminium-zinc alloys and zinc-aluminium alloys — Test methods*

ISO 4519, *Electrodeposited metallic coatings and related finishes — Sampling procedures for inspection by attributes*

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

ISO 9587, *Metallic and other inorganic coatings — Pretreatment of iron or steel to reduce the risk of hydrogen embrittlement*

ISO 9588, *Metallic and other inorganic coatings — Post-coating treatments of iron or steel to reduce the risk of hydrogen embrittlement*

ISO 10289, *Methods for corrosion testing of metallic and other inorganic coatings on metallic substrates — Rating of test specimens and manufactured articles subjected to corrosion tests*

ISO 10587, *Metallic and other inorganic coatings — Test for residual embrittlement in both metallic-coated and uncoated externally-threaded articles and rods — Inclined wedge method*

ISO 15330, *Fasteners — Preloading test for the detection of hydrogen embrittlement — Parallel bearing surface method*

ISO 15724, *Metallic and other inorganic coatings — Electrochemical measurement of diffusible hydrogen in steels — Barnacle electrode method*

3 Terms, definitions, abbreviated terms and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2064 and ISO 2080 apply.

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

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

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

3.2 Abbreviated terms

ER hydrogen embrittlement relief heat treatment

SR stress relief heat treatment

T2 organic sealant

3.3 Symbols

Fe chemical symbol for iron

Zn chemical symbol for zinc

4 Information to be supplied by the purchaser to the electroplater

4.1 Essential information

The following information shall be supplied to the electroplater in writing, for example, in the contract or purchase order, or on engineering drawings:

a) the reference to this document, i.e. ISO 2081, and the designation (see Clause 5);

b) the significant surface indicated, for example, by drawings or by the provision of suitably marked samples;

c) the nature, condition and finish of the basis metal if they are likely to affect the serviceability and/or appearance of the coating (see Clause 1);

d) the position on the surface for unavoidable defects, such as rack marks (see 6.1);

e) the finish required, for example, bright, dull or other finish, preferably accompanied by approved samples of the finish (see 6.1);

f) the type of chromate conversion coating or supplementary treatment (see 6.3 and Annex A); chromate conversion coatings shall only be omitted, and alternative conversion coatings and/or other supplementary treatments, such as lacquers, applied over the chromate conversion coating, at the specific request of the purchaser;

g) the requirements for thickness and adhesion test (see 6.2, 6.4 and Annex B);

h) the tensile strength of the parts and the requirements for heat treatment before and/or after electrodeposition (see 6.6 and 6.7);

i) sampling methods, acceptance levels or any other inspection requirements, if inspection is different from that given in ISO 4519 (see Clause 7);

j) any requirements for accelerated corrosion testing (see 6.5) and rating (see 6.5.2).

4.2 Additional information

The following additional information shall also be supplied to the electroplater:

a) any special requirements for, or restrictions on, preparation of the article to be coated (see References [10] and [11]);

b) any other requirements, such as for articles of complex shape, an area for testing and rating.

5 Designation

5.1 General

The designation shall appear on engineering drawings, in the purchase order, in the contract or in the detailed product specification. The designation specifies, in the following order, the basis metal, stress relief requirements, the type and thickness of undercoats, if present, the thickness of the zinc coating, heat treatment requirements after electroplating, and the type of conversion coating and/or supplementary treatment (see References [17] and [18]).

5.2 Designation specification

The designation shall comprise the following:

a) the term "Electrodeposited coating";

b) the reference to this document, i.e. ISO 2081;

c) a hyphen;

d) the chemical symbol of the basis material, Fe, (iron or steel) followed by its standard designation;

e) a solidus (/);

f) the SR designation, if necessary, followed by a solidus (/);

g) the chemical symbol for zinc, "Zn";

h) a number indicating the minimum local thickness, in micrometres, of the zinc coating followed by a solidus (/);

i) the ER designation, if necessary, followed by a solidus;

j) if appropriate, codes designating the type of chromium conversion coating (see Annex A), followed by a solidus;

k) if appropriate, codes designating any supplementary treatments (see Annex A).

Solidi (/) shall be used to separate data fields in the designation corresponding to the different sequential processing steps.

If supplementary treatments other than or in addition to a transparent chromium conversion coating are used, the designation for a coating thickness of 25 µm of zinc shall be

Fe/Zn25/A/Y

where

A represents the transparent conversion coating

Y represents one of the codes for other supplementary coatings given in Table A.2.

It is recommended that the specific alloy be identified by its standard designation following the chemical symbol of the basis metal; for example, its UNS number, or the national or regional equivalent, may be placed between the symbols, < >.

For example, Fe<G43400> is the UNS designation for one high-strength steel (see Reference [12]).

The following are examples of designations.

EXAMPLE 1

Designation of an electrodeposited coating of 12 µm zinc (Zn12) on iron or steel (Fe) which has had a transparent conversion coating (A) applied:

Electrodeposited coating ISO 2081 – Fe/Zn12/A

EXAMPLE 2

The same as Example 1, but in addition the articles are heat-treated prior to electroplating for stress relief purposes at 200 °C for a minimum of 4 h designated as SR(200)≥4, and heat treated after electroplating and heavyweight trivalent transparent coating (A) for hydrogen embrittlement relief for 8 h at 190 °C, designated as ER(190)8 followed by a sealing treatment consisting of the application of an organic sealant (T2):

Electrodeposited coating ISO 2081 – Fe/SR(200)≥4/Zn12/ER(190)8/A/T2

5.3 Designation of the basis material

The basis material shall be designated by its chemical symbol or its principal constituent if an alloy. For example:

a) Fe for iron or steel;

b) Zn for zinc alloys;

c) Al for aluminium alloys.

5.4 Designation of heat treatment requirements

The heat treatment requirements shall be designated as follows:

a) by the letters SR for stress relief heat treatment prior to electroplating, and/or the letters ER for hydrogen embrittlement relief heat treatment after electroplating;

b) in parentheses, the minimum temperature, expressed in degrees Celsius (°C);

c) the duration, expressed in hours (h), of the heat treatment.

For example, SR(210)1 designates stress relief heat treatment at 210 °C for 1 h.

6 Requirements

6.1 Appearance

Although this document does not specify the condition, finish or surface roughness of the basis material prior to electroplating, the appearance of electroplated coatings depends on the condition of the basis material (see References [10] and [11] for surface preparation). The electroplated article on its significant surface shall be free from clearly visible plating defects such as blisters, pits, roughness, cracks or non-plated areas other than those arising from defects in the basis metal. On articles where a contact mark is unavoidable, its position shall be the subject of agreement between the interested parties (see 4.1). The articles shall be clean and free from damage.

Unless the purchaser specifies otherwise, the zinc coating shall be bright. If necessary, a sample showing the required finish shall be supplied or approved by the purchaser [see 4.1 e)].

6.2 Thickness

The thickness of the coating specified in the designation shall be the minimum local thickness. The minimum local thickness of the coating shall be measured at any point on the significant surface that can be touched by a ball 20 mm in diameter, unless otherwise specified by the purchaser (see 4.1 and 4.2).

Methods for the measurement of the thickness of zinc coatings on steel are specified in ISO 1463, ISO 2177, ISO 2178, ISO 3497, ISO 3543 and ISO 4518.

In case of dispute, the method specified in ISO 1463 shall be used for articles having a significant surface area greater than 100 mm^2. In the case of articles having a significant surface area less than 100 mm^2, the minimum local thickness shall be deemed to be the minimum value of the average thickness determined by the method specified in Annex B.

Prior to the use of the method specified in ISO 2177, it is essential that the chromate coating, other conversion coating or organic coating is removed using a very mild abrasive, for example, a paste of levigated alumina. In the case of heavy conversion coatings, the results will, therefore, be slightly lower.

If the coatings are rough or matte, the microscopical (ISO 1463) and profilometric (ISO 4518) methods may give unreliable results, and magnetic methods may give measurements which are greater than those obtained on smooth coatings of the same mass per unit area.

6.3 Trivalent chromium conversion coatings and other supplementary treatments

Trivalent chromium conversion coatings shall only be omitted, or replaced by other conversion coatings, such as non-chromium or phosphate coatings, at the specific request of the purchaser [see 4.1 f)]. The codes for trivalent chromium conversion coatings and all other supplementary coatings shall be designated as shown in Annex A.

6.4 Adhesion of zinc and trivalent chromium conversion coatings

The zinc coating shall continue to adhere to the basis metal when subjected to the burnishing test specified in ISO 2819. The chromate conversion coatings shall be tested for adhesion in accordance with ISO 3613.

With the exception of thickness testing, all tests shall be carried out no sooner than 24 h after chromium conversion coating treatment.

6.5 Accelerated corrosion testing

6.5.1 Neutral salt spray test

When tested in accordance with the neutral salt spray (NSS) test specified in ISO 9227 for the times given in Table 1, the test surface shall remain free from red and white corrosion products when examined by the unaided eye or with normal corrected vision. Slight staining shall not be a cause for rejection.

The partial coating designation in Table 1 gives the minimum local thickness of zinc after chromium conversion coating treatment, if carried out, for various service conditions. The required thickness of the zinc coating to ensure resistance to corrosion depends on the severity of the service conditions. Coating designation, Fe/Zn5 for example, is recommended only for dry, indoor conditions. As the service conditions become more severe, it is necessary to increase the thickness of the zinc to ensure resistance to corrosion, and to specify zinc coating required with respect to the service condition.

When very long service life is required, as, for example, on structural steel components, the thicker zinc coatings required can be applied by hot-dip zinc coating in accordance with ISO 1461[1].

The duration and results of artificial atmosphere corrosion tests may bear little relationship to the service life of the coated article and, therefore, the results obtained are not to be regarded as a direct guide to the corrosion resistance of the tested coatings in all environments where these coatings may be used.

Table 1 — Neutral salt spray corrosion resistance of zinc plus trivalent chromate conversion coatings before basis metal corrosion (red rust) begins

Type of conversion coating	Type of electroplating	Minimum test time h			
		Without zinc corrosion	Without basis metal corrosion (red rust) as a function of Zn coating thickness		
			5 µm	8 µm	12 µm
Standard transparent conversion coating	Barrel	8	48	72	96
	Rack	16	72	96	120
Iridescent passivate conversion coating	Barrel	72	144	216	288
	Rack	120	192	264	336
Iridescent passivate conversion coating and leach-seal	Barrel	96	240	336	384
	Rack	120	288	360	408

6.5.2 Corrosion rating

After testing, samples shall be rated in accordance with ISO 10289. The acceptable rating shall be specified by the purchaser.

6.6 Stress relief heat treatments before cleaning and metal deposition

When specified by the purchaser, steel parts that have an ultimate tensile strength equal to or greater than 1 000 MPa and that contain tensile stresses caused by machining, grinding, straightening or cold forming operations shall be given a stress relief heat treatment prior to cleaning and metal deposition. The procedures and classes for stress relief heat treatment shall be as specified by the purchaser or the purchaser shall specify appropriate procedures and classes from ISO 9587.

When heat treatment for stress relief prior to electroplating or for hydrogen embrittlement relief after electroplating (see 6.7) are specified, the time and temperature of the heat treatment process shall be included in the coating designation as illustrated in 5.2, 5.3 and 5.4.

Steels with oxide or scale have to be cleaned before application of the coatings. For high strength steels (equal to or greater than 1 000 MPa), non-electrolytic alkaline and anodic alkaline cleaners as well as mechanical cleaning procedures are preferred to avoid the risk of producing hydrogen embrittlement during cleaning procedures (see Reference [10]).

6.7 Hydrogen-embrittlement-relief heat treatments after electroplating

Steel parts having an ultimate tensile strength equal to or greater than 1 000 MPa as well as surface-hardened parts shall receive hydrogen-embrittlement-relief heat treatment according to the procedures and classes of ISO 9588 or as specified by the purchaser.

When heat treatment for stress relief prior to electroplating (see 6.6) or for hydrogen embrittlement relief after electroplating are specified, the time and temperature of the heat treatment process shall be included in the coating designation, as illustrated in 5.4. When the purchaser requires the effectiveness of the hydrogen-embrittlement-relief heat treatment to be determined, and unless specified otherwise, this shall be determined in accordance with ISO 10587 or ISO 15330 for testing threaded articles for residual hydrogen relief heat treatment, and with ISO 15724 for measuring relative, diffusible hydrogen concentration in steels.

7 Sampling

A random sample of the size as specified by ISO 4519 shall be selected from the inspection lot. The articles in the sample shall be inspected for conformance to the requirements of this specification and the lot shall be classified as conforming or not conforming to each requirement in accordance with the criteria of the sampling plans given in ISO 4519. If other form of sampling plan is selected [see 4.1 i)], a random sample shall be selected and the articles in the sample shall be inspected for conformance to the requirements of this document.

Annex A
(normative)

Designation of supplementary treatments

A.1 General

Passivation solutions are usually acidic and might contain hexavalent or trivalent chromium salts, together with other salts which can be varied to affect the appearance and hardness of the film. Clear, bleached, iridescent, olive-green and black films on zinc coating can be obtained by processing in appropriate solutions. Transparent films can also be obtained by bleaching iridescent films in alkaline solutions or in phosphoric acid. Table A.1 gives the approximate surface density (mass per unit area) for each type of chromate conversion coating when measured in accordance with ISO 3892.

Table A.1 — Chromate conversion coating type, appearance and surface density

Type		Typical appearance	Coating surface density
			ρ_A
Code	Name		g/m^2
A	Clear	Transparent, clear to bluish	$\rho_A \leq 0,5$
B[a]	Bleached	Transparent with slight iridescence	$\rho_A \leq 1,0$
C	Iridescent	Yellow iridescent	$0,5 < \rho_A \leq 1,5$
D[b]	Opaque	Olive-green	$\rho_A > 1,5$
F[b]	Black	Black	$0,5 \leq \rho_A \leq 1,0$

NOTE Chromate coatings described in this table might not necessarily be specified for the improvement of the adhesion of paints and varnishes. All chromate coatings might or might not contain hexavalent chromium ions.

[a] This is a two-stage process: yellow iridescent followed by a leaching/sealing solution for hexavalent chromium passivates or a thicker trivalent passivate (sometimes referred to as 'heavyweight') than that used to produce a clear deposit.

[b] Coatings of types D and F are only possible using hexavalent chromium.

A.2 Sealing

In order to give better protection against corrosion, trivalent chromium conversion coatings can be post-treated with sealing agents, by introducing organic or inorganic products into the chromate film. This operation also enhances the resistance of the trivalent chromium conversion coating to higher temperatures.

Sealing can be carried out by dipping or spraying the conversion coating with polymers in aqueous solutions. A similar process is based on the addition of suitable organic products to the chromating solution.

A.3 Supplementary treatments other than trivalent chromium conversion coatings

If a supplementary treatment other than trivalent chromium conversion coatings is required, the type of treatment shall be indicated in accordance with the codes given in Table A.2 below.