
**Fasteners — Non-electrolytically applied
zinc flake coatings**

*Éléments de fixation — Revêtements non électrolytiques de lamelles
de zinc*



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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10683 was prepared by Technical Committee ISO/TC 2, *Fasteners*, Subcommittee SC 1 *Mechanical properties of fasteners*.

Annex A of this International Standard is for information only.

Fasteners — Non-electrolytically applied zinc flake coatings

1 Scope

This International Standard specifies requirements for thickness, corrosion resistance and mechanical and physical properties of non-electrolytically applied zinc flake coatings on steel fasteners with metric threads.

It applies to both coatings with or without chromate.

Coatings according to this International Standard may also be applied to steel screws which form their own mating threads such as wood screws, self tapping screws, self drilling screws, thread cutting screws and thread rolling screws as well as to non-threaded steel parts such as washers and pins.

They may be similarly applied to steel fasteners with other types of thread.

Coatings according to this International Standard can be supplied with integral lubricant and/or with a subsequently added lubricant.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 898-1:1999, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs.*

ISO 965-1:1998, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data.*

ISO 965-2:1998, *ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose external and internal screw threads — Medium quality.*

ISO 965-3:1998, *ISO general purpose metric screw threads — Tolerances — Part 3: Deviations for constructional screw threads.*

ISO 1463:—¹⁾, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method.*

ISO 1502:1996, *ISO general purpose metric screw threads — Gauges and gauging.*

ISO 2064:1996, *Metallic and other inorganic coatings — Definitions and conventions concerning the measurement of thickness.*

1) To be published. (Revision of ISO 1463:1982)

ISO 3269:2000, *Fasteners — Acceptance inspection*.

ISO 8991:1986, *Designation system for fasteners*.

ISO 9227:1990, *Corrosion tests in artificial atmospheres — Salt spray tests*.

ISO 15330:1999, *Fasteners — Preloading test for the detection of hydrogen embrittlement — Parallel bearing surface method*.

3 Terms and definitions

For the purpose of this International Standard, the definitions given in ISO 2064 together with the following apply.

3.1

non-electrolytically applied zinc flake coating (with or without integral lubricant)

coating which is produced by applying to the surface of a fastener a zinc flake dispersion, possibly with the addition of aluminium flakes, in a suitable medium which under influence of heat (curing) generates a bonding amongst flakes and also between flakes and substrate thus forming an inorganic surface coating sufficiently electrically conducting to ensure cathodic protection

NOTE The coating may or may not contain chromate.

4 General characteristics

It is a characteristic of this type of coating that no hydrogen which could be absorbed by the fasteners to be coated is generated during the coating process. Therefore, by using pretreatment cleaning methods which do not generate nascent hydrogen (for example blast cleaning), there is no risk of hydrogen embrittlement from the surface preparation procedure.

If cleaning methods are applied which could lead to hydrogen absorption (such as acid cleaning), then for fasteners with a hardness above 365 HV in-process control shall be conducted to ensure that the process with regard to hydrogen embrittlement is under control. This can be done by a preloading test according to ISO 15330.

However it should be noted that a non-electrolytically applied zinc flake coating has a high permeability for hydrogen which, during the curing process, allows effusion of hydrogen which may have been absorbed before the coating process.

5 Dimensional requirements and testing

Coating thicknesses which can be applied on ISO metric threads in accordance with ISO 965-1, ISO 965-2 and ISO 965-3 depend on the fundamental deviation available as given in Table 1, which itself depends on the screw thread and the following tolerance positions:

- g, f, e for external threads;
- G for internal threads or H if required.

The coating shall not cause the zero line (basic size) to be exceeded in the case of external threads; nor shall it fall below in the case of internal threads. This means that for an internal thread of tolerance position H, a measurable coating thickness can only be applied to the thread if the tolerance zone is not taken up to the zero line (basic size).

Table 1 — Theoretical upper limits of coating thicknesses for ISO metric threads

Pitch P	Nominal thread diameter for coarse- pitch thread ^a d	Internal thread		External thread					
		Tolerance position G		Tolerance position g		Tolerance position f		Tolerance position e	
		Funda- mental deviation	Coating thickness max.	Funda- mental deviation	Coating thickness max.	Funda- mental deviation	Coating thickness max.	Funda- mental deviation	Coating thickness max.
mm	mm	μm	μm	μm	μm	μm	μm	μm	μm
0,2		+ 17	4	– 17	4				
0,25	1; 1,2	+ 18	4	– 18	4				
0,3	1,4	+ 18	4	– 18	4				
0,35	1,5; 1,8	+ 19	4	– 19	4	– 34	8		
0,4	2	+ 19	4	– 19	4	– 34	8		
0,45	2,5; 2,2	+ 20	5	– 20	5	– 35	8		
0,5	3	+ 20	5	– 20	5	– 36	9	– 50	12
0,6	3,5	+ 21	5	– 21	5	– 36	9	– 53	13
0,7	4	+ 22	5	– 22	5	– 38	9	– 56	14
0,75	4,5	+ 22	5	– 22	5	– 38	9	– 56	14
0,8	5	+ 24	6	– 24	6	– 38	9	– 60	15
1	6; 7	+ 26	6	– 26	6	– 40	10	– 60	15
1,25	8	+ 28	7	– 28	7	– 42	10	– 63	15
1,5	10	+ 32	8	– 32	8	– 45	11	– 67	16
1,75	12	+ 34	8	– 34	8	– 48	12	– 71	17
2	16; 14;	+ 38	9	– 38	9	– 52	13	– 71	17
2,5	20; 18; 22	+ 42	10	– 42	10	– 58	14	– 80	20
3	24; 27;	+ 48	12	– 48	12	– 63	15	– 85	21
3,5	30; 33	+ 53	13	– 53	13	– 70	17	– 90	22
4	36; 39	+ 60	15	– 60	15	– 75	18	– 95	23
4,5	42; 45	+ 63	15	– 63	15	– 80	20	– 100	25
5	48; 52	+ 71	17	– 71	17	– 85	21	– 106	26
5,5	56; 60	+ 75	18	– 75	18	– 90	22	– 112	28
6	64	+ 80	20	– 80	20	– 95	23	– 118	29
NOTE Theoretical upper limits of coating thicknesses are calculated on the basis of thread dimensions which are at the lower limit (internal thread) or upper limit (external thread) of the respective thread tolerance.									
^a Information for coarse-pitch threads is given for convenience only. The determining characteristic is the thread pitch.									

After coating, ISO metric screw threads shall be gauged according to ISO 1502 with a GO-gauge of tolerance position h for external threads and H for internal threads. When gauging the coated thread a maximum torque of $0,001 d^3$ (N·m) is acceptable, where d is the nominal thread diameter in mm.

Other product dimensions apply only before coating.

If a minimum coating thickness (t_{\min}) is required in order to achieve a specified corrosion resistance (see clause 6) the range of the coating thickness has to be taken into consideration of which the dimension is approximately the same as the minimum coating thickness itself. Therefore the maximum coating thickness to be expected is twice as much as the required minimum coating thickness, see Table 2. The minimum fundamental deviation required for a specified minimum coating thickness which is $4 t_{\max}$ (or $8 t_{\min}$) is also given in Table 2.

If, for a given pitch the fundamental deviation as given in Table 1 is not sufficient to allow for the required minimum coating thickness then:

- either the tolerance position of the thread has to be changed (e.g. f instead of g);
- or the tolerance within the given tolerance field has to be restricted such that the thread has to be manufactured at the upper limit for the internal thread or at the lower limit for the external thread of the respective tolerance.

Required minimum local coating thicknesses to achieve specified corrosion resistance are given in Table 3.

NOTE Guidance for the choice of coating thickness relating to corrosion protection requirements is given in annex A.

If the minimum local coating thickness is specified (see Table 3) it may be measured by magnetic or X-ray techniques. In the case of dispute the referee test shall be the microscopical method as described in ISO 1463. The surfaces to be used for thickness measurements, measuring areas, are those given in Figure 1.

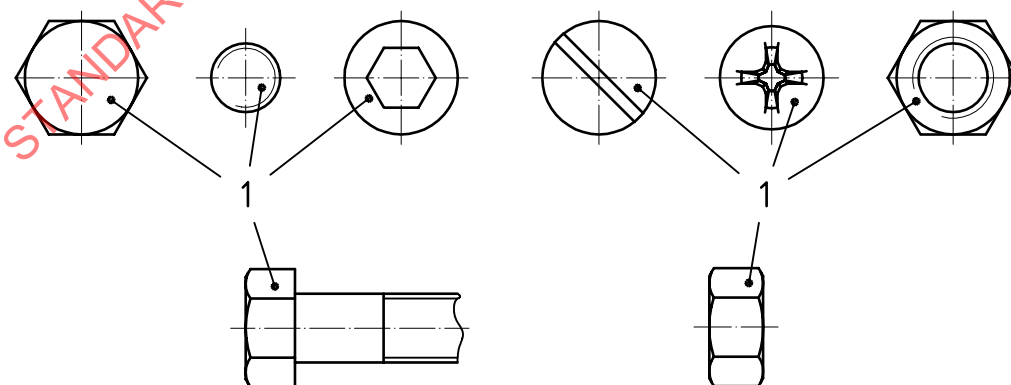
If fasteners with metric thread with pitch below 1 mm (< M6) or fasteners with small internal drives or cavities are to be coated, a special agreement between supplier and purchaser is required.

Table 2 — Coating thickness and required fundamental deviation

Dimensions in micrometres

Coating thickness ^a		Minimum fundamental deviation required
minimum (if required, see Table 3)	maximum (to be expected)	
t_{\min}	t_{\max}	
4	8	32
5	10	40
6	12	48
8	16	64
9	18	72
10	20	80
12	24	96

^a The thickness of coating on the bearing face of fasteners is important with regard to reduction of clamp load due to relaxation.



Key

1 Measuring area

Figure 1 — Measuring area for coating thickness measurement on threaded fasteners

6 Testing of corrosion protection

The neutral salt spray test in accordance with ISO 9227 is used to evaluate the quality of the coating. The test is applied to coated parts which are in the as-delivered condition. Performance in the test cannot be related to corrosion protection behaviour in particular service environments.

NOTE In normal cases the coating should be defined by specifying the test duration for neutral salt spray test from those given in Table 3, see example 1 in clause 9.

After the neutral salt spray test using a test duration as given in Table 3 there shall be no visible ferrous (red) corrosion attack on the base metal.

Table 3 — Test duration (neutral salt spray test)

Test duration h	Minimum local coating thickness (if specified by the purchaser) ^a	
	Coating with chromate (flZnyc) µm	Coating without chromate (flZnnc) µm
240	4	6
480	5	8
720	8	10
960	9	12
NOTE If the coating areic mass in g/m ² is specified by the purchaser, it may be converted into thickness as follows: — coating with chromate: 4,5 g/m ² correspond to a 1 µm thickness — coating without chromate: 3,8 g/m ² correspond to a 1 µm thickness		
^a The purchaser may specify whether he wants to have a coating with chromate (flZnyc) or without chromate (flZnnc); otherwise the symbol flZn is suitable, see clause 9.		

7 Mechanical and physical properties and testing

7.1 General

The coating process shall not adversely influence the mechanical and physical properties of the fasteners as specified in the relevant ISO Standards.

Consideration shall be given by the manufacturer supported by testing if necessary, to determine whether the curing temperature and duration as specified by the coater are suitable for the particular type of fastener to be coated.

7.2 Appearance

The colour of the coating is silver-grey. The coated fastener shall be free from blisters, localized excess coating and uncoated areas which may have adverse effects on corrosion protection and fitness for use.

Special techniques may be necessary to avoid excess coating or uncoated areas with parts such as washers, nuts and recess drive screws.

7.3 Temperature resistance

After heating the coated fasteners for 3 h at 150 °C (component temperature) the corrosion protection requirements as specified in clause 6 shall still be met.

7.4 Ductility

After loading the coated fastener with the proof load specified in ISO 898-1 the corrosion protection as specified in clause 6 shall still be met in areas other than where thread engagement has occurred. This requirement only applies to bolts, screws and studs with metric thread.

7.5 Adhesion/cohesion

If an adhesive tape with an adhesive strength of (7 ± 1) N per 25 mm width is firmly pressed by hand on to the surface and is subsequently pulled off jerkily and perpendicularly to the surface, the coating shall not be peeled off the base metal. Small amounts of the coating material left sticking to the tape are acceptable.

7.6 Cathodic protection

The cathodic protection capability of the coating can be tested by making the salt spray test according to clause 6 with a specimen which is scratched down to the base metal, the scratch having a width of maximum 0,5 mm. After the salt spray test of 72 h duration there shall be no red rust in the scratched area.

7.7 Torque/tension relationship for coatings with integral lubricant or subsequently (externally) added lubricant

The requirements for torque/tension shall be agreed between the manufacturer and purchaser.

8 Applicability of tests

8.1 General

All requirements given in clauses 5, 6 and 7 apply as far as they are general characteristics of the coating or are separately specified by the customer. The tests included in 8.2 shall be carried out for each lot of fasteners (see ISO 3269). The tests included in 8.3 are not intended to be applied for each fastener lot, but are used for in-process control.

8.2 Tests mandatory for each lot

- Gauging of threads (clause 5).
- Appearance (7.2).
- Adhesion/cohesion (7.5).

8.3 Tests to be conducted for in-process control

- Neutral salt spray test (clause 6).
- Temperature resistance (7.3).
- Ductility (7.4).
- Cathodic protection (7.6).

8.4 Tests which are only to be conducted when specified by the customer

- Coating thickness (clause 5).
- Torque/tension relationship for coatings with integral or subsequently added lubricant (7.7).

9 Designation

The designation of the coating shall be added to the product designation in accordance with the designation system specified in ISO 8991 using the symbol flZn for non-electrolytically applied zinc flake coatings, a figure for the required duration of salt spray test in hours and, if necessary, the specification for a coating with chromate (yc) or without chromate (nc).

EXAMPLE 1 Hexagon head bolt ISO 4014 - M12 × 80 - 10.9 with a non-electrolytically applied zinc flake coating (flZn), with a required duration of salt spray test of 480 h is designated as follows:

Hexagon head bolt ISO 4014 - M12 × 80 - 10.9 - flZn - 480 h

If a coating with integral lubricant is required, the letter L shall be added to the designation after the symbol for the zinc flake coating as follows:

Hexagon head bolt ISO 4014 - M12 × 80 - 10.9 - flZnL - 480 h

If a coating with a subsequently added lubricant (external lubricant) is required, the letter L shall be added at the end of the designation as follows:

Hexagon head bolt ISO 4014 - M12 × 80 - 10.9 - flZn - 480 h - L

EXAMPLE 2 Hexagon head bolt ISO 4014 - M12×80 - 10.9 with a non-electrolytically applied zinc flake coating without chromate flZnnc, with a required duration of salt spray test of 480 h is designated as follows:

Hexagon head bolt ISO 4014 - M12 × 80 - 10.9 - flZnnc - 480 h

EXAMPLE 3 Hexagon head bolt ISO 4014 - M12 × 80 - 10.9 with a non-electrolytically applied zinc flake coating with chromate flZnyc, with a required duration of salt spray test of 480 h is designated as follows:

Hexagon head bolt ISO 4014 - M12 × 80 - 10.9 - flZnyc - 480 h

10 Ordering requirements

When ordering threaded parts to be coated according to this International Standard, the following information shall be supplied to the coater:

- a) reference to this International standard and the coating designation (see clause 9);
- b) The material of the component and its condition, i.e. heat treatment, hardness or other properties, which may be influenced by the coating process;
- c) thread tolerances if different from the product standard;
- d) performance (torque/tension, coefficient of friction) and the test methods for integrally lubricated or supplementary lubricated coatings as agreed between the manufacturer and purchaser;
- e) tests to be carried out, if any (see clause 8);
- f) sampling.