INTERNATIONAL STANDARD

ISO 8179-1

Third edition
2017-07

Ductile iron pipes, fittings, accessories and their joints — External zinc-based coating —

Part 1: Metallic zinc with finishing layer

Tuyaux, raccords et accessoires en fonte ductile et leurs assemblages — Revêtement extérieur à base de zinc —

Partie 1: Zinc métallique avec couche de finition

Reference number
ISO 8179-1:2017(E)

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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 Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 2, *Cast iron pipes, fittings and their joints*.

This third edition cancels and replaces the second edition (ISO 8179-1:2004), which has been technically revised. The following changes have been made:

— the minimum quantity of Zn has been increased from 130 g/m^2 to 200 g/m^2;

— the revision recognizes the technological advancements in the field regarding zinc-based coatings to increase the lifetime and reliability of ductile iron pipelines, improving protection to different types of corrosion (including general and localized) and the use of new alloy enrichments.

A list of all parts in the ISO 8179 series can be found on the ISO website.

Ductile iron pipes, fittings, accessories and their joints — External zinc-based coating —

Part 1: Metallic zinc with finishing layer

1 Scope

This document specifies an external protective coating system which is factory applied to ductile iron pipeline components as specified in ISO 2531, ISO 7186 and ISO 16631. This coating system comprises an electro-deposited metallic zinc-based coating of

— pure metallic zinc with a purity of 99,99 %,

— zinc and aluminium alloy with or without other metals, or

— other zinc alloys

followed by a finishing layer that can be bituminous paint or synthetic resin compatible with zinc-based coating.

NOTE ISO 8179-2 deals with zinc-rich paint coating.

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

3 Terms and definitions

No terms and definitions are listed in this document.

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

4 Materials

The coating materials shall be

— pure metallic zinc with a purity of 99,99 %,

— zinc and aluminium alloy with or without other metals, or

— other zinc alloys

followed by a finishing layer that can be bituminous paint or synthetic resin compatible with zinc-based layer.

5 Zinc-based coating

5.1 Pipeline component surface condition

The pipeline component surface shall be dry and free from rust and any non-adhering particles or foreign matter such as oil or grease.

The metallic zinc-based coating shall be applied to the as-cast annealed external surface of the pipeline component, or to a blast-cleaned or ground surface at the manufacturer's discretion.

5.2 Method of application

The metallic zinc-based coating shall be applied by a spraying process in which metallic zinc or zinc alloy is heated to a molten state and projected in small droplets by spray guns on to the pipeline component surface.

The design and construction of the spray equipment are not within the scope of this document.

5.3 Coating characteristics

The metallic zinc-based coating shall cover the outside surface of the pipeline component and shall be free from such defects as bare patches or lack of adhesion.

A spiralled appearance is permissible provided that the zinc-based coating masses comply with the requirements of 5.4.

The manufacturer shall define those coating irregularities which are considered not detrimental to the performance of the coating system.

Damaged areas of zinc-based coating caused by handling are acceptable, provided that the area of damage is less than 5 cm^2 per square metre and that the minor dimension of the damaged area does not exceed 5 mm.

Greater areas of damage shall be repaired in accordance with 5.5.

5.4 Zinc-based coating mass

The mean mass of zinc-based coating measured in accordance with 7.1 shall be as follows:

— not less than 200 g/m^2 with a local minimum of 180 g/m^2;

— in low corrosive areas, by agreement between the purchaser and the supplier, 130 g/m^2 of zinc with a local minimum of 110 g/m^2;

— in case of very corrosive soils, the manufacturer and the purchaser may decide to use additional coating mass.

The manufacturer shall visually inspect each pipeline component for quality and uniformity of coating and shall carry out regular measurements of zinc-based coating masses in accordance with the method described in 7.1.

The factory quality control tests ensure conformity to the standard. Factory quality control tests shall be the sole determinant of coating thickness acceptance. Where informative field verification is required, one of the methods described in Annex A shall be agreed upon between the manufacturer and the purchaser.

For the selection of coatings in relation to the characteristics of soils, Annex B can be consulted.

5.5 Repairs to the zinc-based coating

Areas left uncoated, e.g. under the test token, and coating damage in excess of that permitted in 5.3 shall be repaired by either

a) metallic zinc spray complying with 5.4, or

b) application of a zinc-rich paint containing more than 85 % zinc, by mass, in the dried film. The mean mass of the applied paint shall not be less than 20 % above the nominal coating mass of the metallic zinc-based coating.

6 Finishing layer

After the zinc-based coating has been applied, the pipeline component shall be given a finishing layer of bituminous paint or synthetic resin compatible with the zinc-based coating.

Application of this finishing layer may be done by any proven process such as spraying or brush coating at the manufacturer's discretion. It shall uniformly cover the zinc-based coating and be free from bare patches or lack of adhesion.

The mean dry film thickness of the finishing layer measured in accordance with 7.2 shall be not less than 70 µm with a local minimum thickness of 50 µm. The method of coating thickness measurement is at the manufacturer's discretion.

In order to avoid blistering, the mean dry film thickness of the finishing layer shall not exceed 250 µm.

7 Test methods

7.1 Determination of zinc-based coating mass

A rectangular token is attached along the pipeline component axis before passing it through the zinc-based coating equipment. The minimum token sizes shall be either

a) 250 mm × 100 mm, or

b) 500 mm × 50 mm.

The token shall be a film of consistent thickness and density, stable at the temperature of the substrate during zinc-based application, for use as a surrogate surface for the measurement of coating thicknesses.

The mean mass of zinc-based coating, m, expressed in grams per square metre (g/m^2), is calculated from the mass difference of the token before and after zinc-based coating using Formula (1):

$$m = \frac{C\left(m_2 - m_1\right)}{A} \tag{1}$$

where

m_1 is the mass before zinc coating, measured to an accuracy of 0,1 g, in grams;

m_2 is the mass after zinc coating, measured to an accuracy of 0,1 g, in grams;

A is the area of the token, in square metres;

C is a correction factor depending on the material of the token, taking into account the difference in surface roughness between the token and the pipeline component surface.

The value of C shall be determined by the manufacturer and specified when required in test documents.

NOTE For information, C lies between 1,0 and 1,2 for sand-blasted steel sheets or polyester sheets.

The value for m_2 should be measured after the sample has been dried.

The uniformity of the zinc-based coating is checked by visual inspection of the token. In the event of lack of uniformity, pieces sized 50 mm × 50 mm shall be cut from the token in those zones which appear to have the lower coating mass and the local minimum mass of zinc determined according to the above method.

7.2 Determination of the dry film thickness of the finishing layer

The dry film thickness of the finishing layer shall be measured indirectly on a sample token, which is attached to the pipeline component before coating and is used after coating to measure the dry film thickness.

A rectangular token is attached along the pipeline component axis before coating. The minimum token sizes shall be either

a) 250 mm × 100 mm, or

b) 500 mm × 50 mm.

The token shall be a film of consistent thickness and density, stable at the temperature of the substrate during the coating application, for use as a surrogate surface for the measurement of coating thicknesses.

The dry film thickness is measured either by means of a micrometer or by a weighing method similar to 7.1.

The mean dry film thickness is either

— the average of 10 or more micrometer readings evenly distributed over the surface of the token (after subtraction of the mean thickness of the bare token from each reading), or

— the thickness calculated from the mean mass of finishing layer (measured on the token) and the density of the dry film.

The uniformity of the coating is checked by visual inspection of the token. In the event of lack of uniformity, pieces sized 50 mm × 50 mm shall be cut from the token in those zones which appear to have the lower coating mass and the local minimum thickness determined according to the above method.

The local minimum thickness is either

— the average of four micrometer readings evenly distributed on the surface of a 50 mm × 50 mm piece, or

— the thickness calculated from the mass of finishing layer (measured on a 50 mm × 50 mm piece).

As an alternative to the above reference method, the dry film thickness may also be measured directly on the pipeline components by means of suitable gauges, e.g. magnetic, or by using a “wet film” thickness gauge where a correlation between wet film thickness and dry film thickness can be demonstrated or by any appropriate method defined in ISO 2808. The method of coating thickness measurement is at the manufacturer’s discretion.

Annex A
(informative)

Field verification of the metallic zinc-based coating mass on a finished product

A.1 General

Accurate measurement of metallic zinc-based coating mass can only be carried out during production due to the absence of the finishing layer.

If the purchaser requests at the time of order to carry out a test on a finished product, the methods in A.2, A.3 or A.4 or direct scanning can be used by agreement (in the presence and under recommendation of the manufacturer), with factory patterns used as reference and including measurement accuracy and correlations.

In all methods, care should be taken when removing the finishing layer, otherwise, results may be affected (due to the risk of epoxy inclusion or burn off of zinc during test preparation). If needed, the ways to remove the finishing coatings (i.e. solvents) may be agreed or it may be decided to not remove the finishing layer (i.e. in the case of SEM).

A.2 Metal determination by gas evolution

Purpose: To determine the amount of metal (zinc and/or alloy) present on an iron substrate.

Equipment: A graduated burette, a funnel with the top area ≥2 500 mm^2 and an inhibited hydrochloric acid (HCl) solution (see Figure A.1).

Procedure (derived from Reference [7]): Determination of the volume of hydrogen evolved during localized acid attack on a coated specimen.

a) Remove the finishing coat, if present.

b) Place the funnel on the specimen surface using beeswax or neutral cured silicone sealant to restrict the area attacked by the acid.

c) Fill the funnel with water. Check for leak tightness and retarding of subsequent HCl attack.

d) Install the burette on the funnel.

e) Open stopper 1 to provide HCl access to the metal.

f) Adjust the level in the burette by using the reserve and stopper 2.

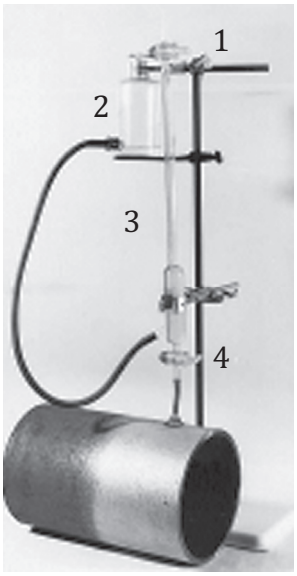
g) After dissolution and cessation of hydrogen evolution, measure the volume of hydrogen evolved and rinse the surface.

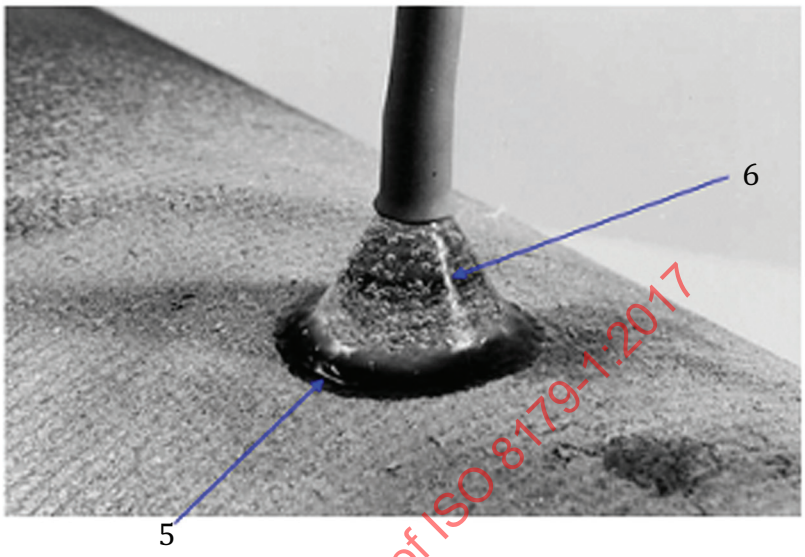
h) Use tracing paper to determine the area attacked.

Reagent: Mix 37 % hydrochloric acid solution with water at a ratio of 50:50 (volume fraction) and add 1 % of hexamine tetramine (inhibitor).

Results: Determination of the volume of hydrogen evolved is related to the acid attacked area. The inhibitor ensures that the ductile iron of the pipeline component is not affected.

Data usage: Calculation of the quantity of zinc metal in a metallic state by converting the volume of hydrogen per mass/unit area using a conversion coefficient.





Key

1	stopper 2 (to adjust the level in the burette)	4	stopper 1 (to provide HCl access to the metal)
2	reserve of inhibited hydrochloric acid (HCl) solution	5	beeswax
3	graduated burette	6	funnel

Figure A.1 — Required equipment

A.3 Zinc/zinc alloy mass determination by gravimetric method

Purpose: Methodology comprising gravimetric method to weigh and measure metallic coated pipeline component with finishing layer combined with an optional scanning electron microscope (SEM) analysis to verify the nature of the metallic coating.

Procedure (derived from References [4] and [6]): Removal of the finishing layer and gravimetric test.

This test measures the weight of the metallic zinc-based coating applied on the ductile iron pipeline components in accordance with this document.

a) Select a pipeline component coated with zinc-based coating with its epoxy paint or varnish and check that the outer coating is intact.

b) Cut a slice in the middle of the pipeline component using a cutting machine and then use a slow rotation grinder coupled to a water cooling system to obtain three samples of at least 50 mm × 50 mm.

c) Select a convection oven with a maximum temperature above 400 °C and an accuracy of ±5 °C. Arrange the samples on a firebrick and bake them at 400 °C for four hours.

d) Carefully remove the burnt finishing layer using a compressed air gun.

NOTE The use of a brush would damage the metallic zinc-based coating.

e) Cool the samples to room temperature and wash them with tap water and dry them with an air pistol.

f) Precisely measure the length and width of each sample surface using a digital calliper.

g) Weigh the samples using a balance with an accuracy of ±0,01 g.

h) Mix a 37 % hydrochloric acid solution with water at a ratio of 50:50 (volume fraction) and add 1 % of hexamine tetramine (inhibitor) and let it stabilize for a few seconds.

i) Gently submerge the sample using tweezers and allow the metallic zinc-based coating to dissolve in the solution at room temperature until the violent evolution of hydrogen stops and only a few bubbles appear on the surface, ensuring that ductile iron of the pipeline component is not affected. Then, remove the sample from the solution and plunge it into a vessel filled with water.

j) Dry the two faces of the sample using the air pistol and weigh it on the electronic scale.

k) Determine the mass using the formula: weight before dissolution of the metallic zinc-based coating — weight after dissolution of the metallic zinc-based coating/area. Check conformity with the requirements of this document.

l) Repeat the procedure for the other two samples.

A.4 Analysis of the metallic zinc-based coating by scanning electron microscope (SEM)

Purpose: To verify the nature of the metallic zinc-based coating applied on ductile iron pipeline components.

a) Use a sample prepared as per A.3 to the stage of when the finishing layer has been removed.

b) Several SEM measurements (thickness and chemical analysis) should be performed on different regions of the samples' surface and at different magnification levels. All measurements obtained shall confirm the presence of metallic zinc.

Annex B
(informative)

Field of use in relation to the characteristics of soils

B.1 General

This annex considers the state of the art of the zinc-based coatings and may be revised taking into account WG23 activity regarding pipeline protection.

B.2 Standard coating

NOTE A standard coating comprises of 200g/m^2 metallic zinc and equivalent zinc-rich paint.

Ductile iron pipeline components may be buried in contact with a large number of soils, which can be identified by soil studies on site, except for the following:

— soils with a low resistivity, less than 1 500 ohm·cm when laid above the water table or less than 2 500 ohm·cm when laid below the water table;

— mixed soils, i.e. comprising two or more soil natures;

— soils with a pH below 6 and a high reserve of acidity;

— soils containing refuse, cinders, slags or polluted by wastes or industrial effluents.

In such soils, and also in the occurrence of stray currents, it is recommended that an additional protection is used (such as polyethylene sleeving) or other types of external coatings as appropriate.

A thicker finishing layer (e.g. 100 µm local minimum of polyurethane or epoxy) may extend the field of use to a resistivity of 1 000 ohm·cm when laid above the water table and of 1 500 ohm·cm when laid below the water table.

B.3 Zinc and aluminium alloy with or without other metals

NOTE A standard zinc and aluminium alloy coating comprises metallic zinc aluminium alloy of 400 g/m^2 with a synthetic paint finishing layer.

Ductile iron pipeline components coated with an alloy of zinc and aluminium with or without other metals or other zinc alloys having a minimum mass of 400 g/m^2 with synthetic paint finishing layer may be buried in contact with the majority of soils, except for the following:

— acidic peaty soils;

— soils containing refuse, cinders, slag, or polluted by wastes or industrial effluents;

— soils below the marine water table with a resistivity lower than 500 ohm·cm.

In such soils, and also in the occurrence of stray currents, it is recommended to use other types of external coatings adapted to the most corrosive soils.

Evidence of the long term performance of the above-mentioned solution (e.g. tests and references) should be provided by the manufacturer.

Addition of other metals to the zinc aluminium alloy may expand the above-mentioned field of use. Evidence of field use and long term performance should be demonstrated by the manufacturer.