INTERNATIONAL STANDARD

ISO 2063

Second edition
1991-11-01

Metallic and other inorganic coatings — Thermal spraying — Zinc, aluminium and their alloys

Revêtements métalliques et inorganiques — Projection thermique — Zinc, aluminium et alliages de ces métaux

Reference number
ISO 2063:1991(E)

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.

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.

International Standard ISO 2063 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Sub-Committee SC 5, *Metal spraying*.

This second edition cancels and replaces the first edition (ISO 2063:1973), of which it constitutes a technical revision.

Annex A forms an integral part of this International Standard. Annex B is for information only.

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Introduction

Thermal sprayed metallic coatings are produced by projecting the coating metal heated to its molten state, in a stream of gas, onto the surface to be coated.

It is essential that the purchaser specifies the coating metal or alloy and the thickness of the coating required: merely to ask for thermal metal spraying to be carried out in accordance with ISO 2063, without this information, is insufficient.

It is essential that the design of the article enables it to be coated properly.

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Metallic and other inorganic coatings — Thermal spraying — Zinc, aluminium and their alloys

1 Scope

This International Standard deals with characteristic properties and gives test methods for coatings obtained by the spraying of zinc and aluminium and their alloys for the general purpose of corrosion protection.

It gives firstly the definition, classification and symbols for these coatings in relation to their thickness.

It then deals with the preparation of surfaces, application of coatings and their characteristic properties: namely, thickness, appearance and adhesion.

Finally it gives test methods for checking these properties.

It does not deal with repairs to damaged metal areas.

This International Standard applies to thermal-sprayed metallic coatings for the protection of iron and steel against corrosion by applying zinc or aluminium or their alloys to the surface to be protected.

It does not, in general, apply to coatings obtained by the application of metals other than zinc or aluminium, although for other metals some of the provisions are valid and may be adopted by agreement between the interested parties.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/R 115:1968, *Classification and composition of unalloyed aluminium ingots for remelting.*

ISO 209-1:1989, *Wrought aluminium and aluminium alloys — Chemical composition and forms of products — Part 1: Chemical composition.*

ISO 752:1981, *Zinc ingots.*

ISO 1463:1982, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method.*

ISO 2064:1980, *Metallic and other non-organic coatings — Definitions and conventions concerning the measurement of thickness.*

ISO 2178:1982, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method.*

ISO 8501-1:1988, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 2064 and in particular the following, apply.

3.1 significant surface: The part of the article covered or to be covered by the coating and for which the coating is essential for serviceability and/or appearance.

3.2 minimum local thickness: The lowest value of the local thickness found on the significant surface of a single article.

4 Manner of specifying requirements

When specifying the coating of articles by thermal spraying in accordance with this International Standard, the purchaser shall state, in addition to the number of the International Standard, the significant surface of the metal coating and its thickness in accordance with the symbols indicated in table 1.

5 Classification

The zinc, aluminium or Zn-Al alloy coatings considered in this International Standard are classified in a scale according to their thickness, in conformity with the indications in table 1.

6 Manufacture

6.1 Preparation of surfaces to be coated by thermal spraying[1)]

The surface shall be thoroughly cleaned and roughened with a suitable abrasive grit. Blasting shall be continued until the surface has a white metallic appearance and uniform texture.

Immediately before spraying, the surface shall be dry and free from dust, grease, scale, rust and other contaminants including soluble salts.

Table 1 — Classification of sprayed metal coatings

This classification gives a series of thickness values applicable to zinc, aluminium and Zn-Al alloy coatings. Intermediate values may be specified by agreement between the parties concerned. The symbol corresponding to each coating shall be composed of the symbol for the metal used (Zn = zinc, Al = aluminium) followed by the minimum local thickness.[1)]

	Minimum local thickness					
U.S. milli-inches	2	4	6	8	10	12
Zinc						
Al						
Al Mg5						
Zn Al15						
Micrometres[2)]	50[3)]		150		250	
		100		200		300[4)]

1) To specify an alloy coating, the chemical symbol corresponding to each element should be followed by the alloy content in mass percentage of this element; e.g. a coating of 120 µm consisting of 85 % zinc/15 % aluminium alloy shall be specified as: Zn 85 Al 15)120, the parentheses being essential for the identification of the alloy terms. If the coating is obtained using an alloy whose symbol appears in another International Standard, that symbol shall be used: e.g. 150 µm of 95 % Al/5 % Mg alloy shall be specified as: (ISO 209: Al Mg5)150.

2) In conformity with ISO 2064.

3) Thicknesses requiring an agreement between the interested parties, notably on the spraying technique used to achieve uniformity of thickness, the use of paints or sealers and the test methods.

4) By special agreement between the interested parties, greater minimum thicknesses may be used if the coating obtained remains in conformity with this International Standard.

1) This subclause specifies the most important elements of surface preparation before thermal spraying of zinc, aluminium and their alloys. For more detailed specifications, refer to ISO 8504-2, *Preparation of steel substrates before application of paint and related products — Surface preparation methods — Part 2: Abrasive blast-cleaning* (to be published).

In all cases, the roughness of the surface shall be verified by comparison with a reference surface having similar properties to the workpiece, prepared according to specifications agreed between the interested parties.

Unless otherwise specified, one of the following abrasives shall be used in the preparation of the surface:

— hematitic chilled cast iron grit;

— aluminium oxide grit.

In certain cases in some countries[2], other abrasives may be used, by agreement between the interested parties, but with special precautions to achieve sufficient roughness to ensure the adhesion of the sprayed metal.

The grit size of the abrasive is generally between 0,5 mm and 1,5 mm.

The abrasive used, whatever its type, shall be clean and dry and, in particular, free from soluble salts. In the case of abrasive blasting using compressed air, the air shall be sufficiently clean and dry to prevent contamination of the abrasive or the surface to be sprayed with metal.

Furthermore, it is desirable to check the cleanliness of the gritblasted surface using "grade Sa 3" according to ISO 8501-1.

6.2 Coating metal

The coating metal shall comply with the following conditions:

— Zinc: zinc having a composition in accordance with type Zn 99,99 of ISO 752.

— Aluminium: aluminium of a quality at least equal to that of type Al 99,5 (1050A) of ISO 209-1.

— Zinc alloys: alloy basis shall be Zn 99,99 zinc (in accordance with ISO 752) and Al 99,7 aluminium [in accordance with ISO 209-1 (Al 1070)]. The alloy composition shall be indicated as in note 1) of table 1. The tolerance for alloy metals shall be ±1 % of the nominal percentage content unless otherwise specified. For example, zinc-aluminium alloys from 87 % zinc/13 % aluminium to 65 % zinc/35 % aluminium can be used. The preferred alloy is 85 % zinc/15 % aluminium. Appropriate symbols shall be used.

— Aluminium alloy: aluminium alloy with 5 % magnesium, Al Mg5 in accordance with ISO 209-1 can be used.

6.3 Thermal spraying

The thermal spraying shall be carried out after the surface has been prepared by abrasive blasting, within a period that allows the metal to be sprayed onto a prepared surface which is still clean, dry and not visibly oxidized.

This time allowed shall be as short as possible and shall be less than 4 h depending on local conditions.

Spraying shall not be carried out under conditions leading to condensation on the surface to be sprayed and the surface shall be maintained at a temperature above the dew-point.

Thermal spraying shall be performed when the steel temperature is at least 3 °C above the dew-point to avoid blistering.

If a deterioration of the surface to be coated is observed, the preparation treatment shall be repeated on the surface to be coated (see 6.1).

6.4 Sealing or painting

6.4.1 The purpose of metallic coating sealing is to seal porosities as much as possible.

6.4.2 Natural sealing can be achieved by oxidation of the metallic coating under normal environmental exposure conditions when the resulting oxides, hydroxides and/or basic salts are not soluble in this environment.

6.4.3 Artificial sealing can be achieved either by chemical conversion of the metallic coating surface (by phosphating, reactive painting, etc.) or by applying an appropriate paint system to close porosities.

6.4.4 Painting of sealed or unsealed metallic coatings may be done either for aesthetic reasons or to extend the service life of the protective system.

6.4.5 Painting is not recommended after natural sealing of the metallic coating.

6.4.6 Whether the metallic coating is sealed or not, the system of painting shall be compatible with the substrate, and shall meet the requirements for durability, maintenance and resistance of the paint to the exposure environment.

2) In some countries, the use of dry siliceous material is subject to statutory regulations.

7 Required characteristics

7.1 Thickness

Metallic coatings deposited by thermal spraying are defined by their minimum local thickness (see 3.2).

The method of measurement, the number and distribution of the measurements over the whole surface area treated shall be agreed upon between the supplier and the purchaser.

7.1.1 Coatings with a surface area of between 1 cm^2 and 1 m^2

In the case of coatings with a surface area of between 1 cm^2 and 1 m^2, the local thickness at any given point shall be the coating thickness measured on a reference surface which is approximately 1 cm^2 in area.

Since the various methods available produce thickness determinations over measurement surfaces of different sizes, one uses the following methods to determine the local thickness at any given point (see figure 1):

— only one measurement, if the measurement surface has an area of not less than 1 cm^2;

— the arithmetic mean of 10 measurements evenly distributed over a distance of between 1 cm and 2 cm, in the case of curvilinear or rectilinear measurements: this is the case of the micrographic section;

— only one measurement, if the diameter of the measurement surface is greater than 5 mm;

— the arithmetic mean of two measurements distributed within an area of 1 cm^2, if the diameter of the measurement surface lies between 3 mm and 5 mm;

— the arithmetic mean of three measurements distributed within an area of 1 cm^2, if the diameter of the measurement surface is less than 3 mm;

— the arithmetic mean of five measurements distributed within an area of 1 cm^2, if pinpoint measurements are taken.

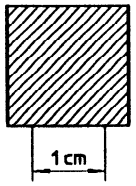
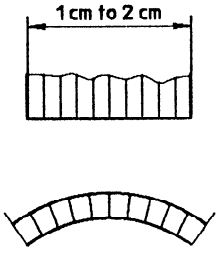
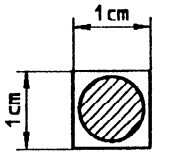
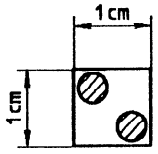
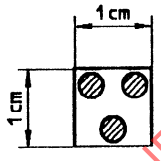
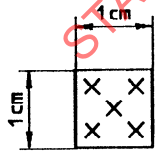
Local thickness		
Determination of minimum thickness on a reference surface of about 1 cm^2		
Number and distribution of measurements		Size of measurement surface for method used
	One measurement only	Measurement surface greater than 1 cm^2
	Arithmetic mean of 10 measurements evenly distributed over a distance of between 1 cm and 2 cm	Linear measurements in a plane of orthogonal section to the coating (micrographic section)
		
	One measurement only	Diameter of the measurement surface lies between 5 mm and 10 mm
	Arithmetic mean of two measurements	Diameter of the measurement surface lies between 3 mm and 5 mm
	Arithmetic mean of three measurements	Diameter of the measurement surface is less than 3 mm
	Arithmetic mean of five measurements	Pinpoint measurements

Figure 1 — Conventions for the determination of local thickness at a given point

7.1.2 Coatings with a surface area greater than 1 m^2

In the case of coatings with a surface area greater than 1 m^2, the local thickness at any given point is the thickness of the coating measured on a reference surface which shall be approximately 1 dm^2 in area.

Since the various methods available produce thickness determinations over measurement surfaces of different sizes, the following methods are used to determine the local thickness at any given point:

— only one measurement, if the measurement surface has an area of not less than 1 dm^2;

— the arithmetic mean of 10 measurements distributed over the reference square decimetre in accordance with the diagram in figure 2, if the measurement surface is a pinpoint or lies between a pinpoint and a few square centimetres.

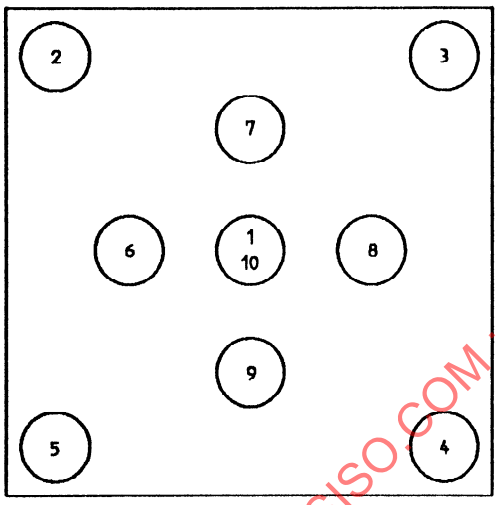


Figure 2 — Distribution of measurement points in the reference square decimetre

7.1.3 Location of thickness test points

The measurement of the local thickness for the purpose of determining the minimum characteristic thickness of the coating takes place in practice at points at which the thickness of the coating is presumed to be at its lowest. These points, and their number, may be defined by agreement between the parties concerned and stipulated at the time of placing the order. It is recommended that these points should, wherever possible, be those specified in the product standards. In the absence of any agreement between the parties concerned, the choice of these points is left to the discretion of the customer.

7.1.4 Methods of measurement

The measurements of thickness shall be made by magnetic measuring methods (see 8.1.2) which can be used in all cases, provided that specifications are observed concernng the number of measurements which must be used to obtain the arithmetic mean.

In the case of dispute, use the micrographic cross-section method if this is possible (see 8.1.3).

7.2 Appearance

The surface of the coating shall be of uniform appearance, without blisters or bare patches, and free from non-adhering metal and defects which can be detrimental to the service life and expected use of the protective coating.

7.3 Adhesion

If at the end of the test no separation from the basis metal or within the metallic coating has occured, the coating shall be deemed to have satisfied the adhesion test (see 8.2).

8 Tests methods

8.1 Measurement of thickness

8.1.1 Field of application of the methods

8.1.1.1 Magnetic measurements have the advantage of being non-destructive, rapid and capable of being carried out directly at any point on the surface to be controlled. Furthermore, the nature of the coating (zinc, aluminium) sprayed onto a ferrous metal, and the values of the standard thicknesses, contribute to the achievement of satisfactory accuracy. As a result, in conformity with the specifications of this International Standard and by agreement between the interested parties on the correct calibration of magnetic instruments for a given sample, magnetic measurements make it possible to carry out effective and accurate acceptance checks.

8.1.1.2 The micrographic cross-section method, used as a reference method for metallic coatings, is difficult to perform correctly for a sprayed metallic coating, and its interpretation may not give the required accuracy in view of the geometrical surface irregularities presented by the basis metal at the interface and by the coating metal at the surface. Therefore, this method shall be used only after prior agreement between the interested parties, the test being made according to the requirements of 8.1.3.

8.1.2 Magnetic measuring method

The tests shall be carried out according to ISO 2178.

8.1.3 Micrographic cross-section

8.1.3.1 Principle

Micrographic examination by means of a microscope, on the cross-section of a test piece cut from the sample, in accordance with the specifications of ISO 1463.

8.1.3.2 Comments

In order to prevent the separation of the coating from the substrate and rounding of the edges, the test piece shall be mounted in an appropriate mounting material such as a plastic or a low melting point alloy. The surface to be examined shall be carefully polished with a suitable material.

Ten measurements shall be made, uniformly distributed along one of the sides of the test piece and covering approximately the 20 mm length of the cross-section (object surface), and the arithmetic mean of these measurements shall be taken.

8.2 Adhesion test[3)]

The choice of the test method and its interpretation shall be carried out by agreement between the interested parties. An explanation of the methods is given in annex A.

3) This subclause is valid until the adoption of an International Standard applying to all metallic coatings.

Annex A
(normative)

Adhesion test methods

A.1 Grid test

A.1.1 Principle

Cutting through the coating to the basis metal to give a lattice pattern having squares of specified dimensions. No separation of the coating shall occur.

A.1.2 Apparatus

A.1.2.1 Cutting tool with a hard point, of a type similar to that shown in figure A.1.

A.1.3 Procedure

Using the tool (A.1.2), cut a lattice of the dimensions given in table A.1.

Table A.1 — Lattice dimensions

Approximate surface covered by the lattice	Thickness of coating verified µm	Distance between cuts mm
15 mm × 15 mm	⩽ 200	3
25 mm × 25 mm	> 200	5

The depth of the cuts shall be such that the coating is cut through to the basis metal.

Wherever possible, after the lattice has been cut, apply a suitable adhesive tape, agreed upon between the interested parties, to this part by means of a roller with a loading of 5 N. Then pull off the adhesive tape quickly and abruptly, in a direction perpendicular to the surface.

If this is not possible, the method of scribing the coating shall be agreed upon between the interested parties.

A.1.4 Interpretation of results

No part of the coating shall separate from the basis metal. The adhesion shall be considered satisfactory if, in each square of the grid, part of the coating still adheres while the remainder is stuck to the adhesive tape, breakage having occurred within the layer of coating metal and not at the interface.

A.2 Tensile test method

Cut through the metallic coating to the basis metal along a circle of diameter corresponding to that of the cylinder to be used for the test.

Carefully clean the area to be tested. Glue a cylinder onto the coating. Use an adhesive having better adhesion to the coating than the coating has to the basis metal. Cover the coating first with a wash primer to prevent the adhesive penetrating to the basis material.

When the adhesive has hardened, cut away the excess adhesive around the cylinder.

Exert an increasing force normal to the surface on the cylinder, and measure the tensile force needed to separate the coating from the basis metal.

The difficulty of reproducing such tests in two different laboratories makes a comparison of test results unpractical. In consequence, this test method can only be applied within one laboratory to compare coating adhesion regularity, it being understood that tests shall always be carried out under the same conditions of installation and by the same operator using the same adhesive on the same coating type.