INTERNATIONAL STANDARD

ISO 7989-1

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Steel wire and wire products — Non-ferrous metallic coatings on steel wire —

Part 1: General principles

Fils et produits tréfilés en acier — Revêtements métalliques non ferreux sur fils d'acier —

Partie 1: Principes généraux

Reference number
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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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 7989-1 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 17, *Steel wire rod and wire products*.

This first edition of ISO 7989-1, together with ISO 7989-2, cancels and replaces ISO 7989:1988, which has been technically revised.

ISO 7989 consists of the following parts, under the general title *Steel wire and wire products — Non-ferrous metallic coatings on steel wire*:

— *Part 1: General principles*

— *Part 2: Zinc or zinc-alloy coating*

Steel wire and wire products — Non-ferrous metallic coatings on steel wire —

Part 1: General principles

1 Scope

This part of ISO 7989 specifies the requirements for the coating mass per unit area, for other properties and also for testing of non-ferrous metallic coatings on steel wire products, of circular or other cross-section.

This part of ISO 7989 deals with general application requirements, and is of use for those coatings for which no particular requirements have been laid down in ISO 7989-2. Deviations are possible, particularly if required for well-defined products. In such cases, appropriate requirements are part of the relevant product standard.

2 Normative references

The following referenced documents are indispensable for the application 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 404:1992, *Steel and steel products — General technical delivery requirements*

ISO 7802:1983, *Metallic materials — Wire — Wrapping test*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
wire with non-ferrous metallic coating
wire to which a non-ferrous metallic coating has been applied

NOTE Depending on the metal, the coating may be obtained by dipping in a bath of molten metal, by conversion using a bath of metallic salts in solution, by extrusion, by cladding, by electroplating using an electrolytic solution or by other methods.

4 Requirements relating to coating

4.1 Requirements for the specific type of metal and alloy

The type, quality and grade of coating metal or alloy shall be stated at the time of inquiry and order.

4.2 Coating mass per unit area

The coating mass per unit area shall be explicitly specified, preferably by reference to the appropriate product standard. If not, ISO 7989-2 shall apply.

The coating mass per unit area shall preferably be expressed as being the coating mass per unit of surface area of bare wire (g/m^2). Other expressions may be accepted, such as the quantity of coating per unit of weight of coated wire or the thickness of coating. This last term is generally expressed as being the minimum required thickness.

NOTE The thickness of the coating may be converted into an equivalent mass per unit of surface area of bare wire or vice versa on the basis of the specific mass of the coating material (see Table 1).

A coating of 1 μm gives a diameter which is 2 μm greater.

Table 1 — Coating mass per unit area (g/m^2) equivalent to a thickness of 1 micrometer (μm)

Metal or alloy	Coating mass per unit area g/m^2
Al	2,69
Cu	8,96
Cu-Sn 91-09	8,56
Cu-Zn 63-37	8,47
Ni	8,85
Sn	7,28
Zn	7,14
Zn95Al5	6,58

4.3 Appearance of coating

The coating shall be reasonably smooth, as evenly distributed as industrially practicable and not show discontinuities such as bare patches, dross contamination, etc.

4.4 Special finishes

If the purchaser requires a special finish, e.g. wax-coating, agreed upon at the time of inquiry and order, or sets out additional requirements for the coating, these special details shall be agreed upon at the time of inquiry and order. The inspection methods shall be defined at the same time.

4.5 Adherence of coating

The adherence wrapping test shall be carried out in accordance with ISO 7802 and the coating shall adhere to the steel below the coating. It shall not crack or split to such an extent that slivers of coating can be removed by simply rubbing with the fingers. The flaking or removal during testing of small particles resulting from mechanical polishing of the coating surface or by contact with the forming equipment shall not be considered to be a cause for rejection.

The wrapping test shall be carried out on wire with a nominal diameter of 7,5 mm or less. Unless otherwise specified, the relationship between the diameter of the coiling mandrel and the diameter of the wire shall be in accordance with 5.3.

In the case of a diameter greater than 7,5 mm, the wrapping test shall be replaced by a bending test in which the wire is bent to least 90° around the mandrel.

5 Test conditions

5.1 Selection of samples

The number and the basis for the selection of test pieces shall be defined in the product specification. In the absence of such a standard, the manufacturer and purchaser shall agree between them on the degree of sampling.

When taking the samples, care shall be taken to avoid damaging the surface. Parts of the wire which are visibly damaged shall not be used.

A test piece of a suitable length for the specified tests shall be taken from one or both ends of each coil selected for sampling.

5.2 Determination of the coating mass per unit area

5.2.1 Gravimetric method

5.2.1.1 General

The coating mass per unit area shall be determined using a gravimetric method. The metallic coating on a surface of known area is dissolved in a suitable solution to remove the coating completely without attacking the surface of the steel wire. If necessary a suitable inhibitor is added to the solution. The resulting mass loss is determined by weighing the test piece before and after the coating has dissolved.

5.2.1.2 Procedure

If necessary, the test piece shall be degreased using an organic solvent which does not attack the coating and the test piece shall then be dried.

Before stripping, the test piece shall be weighed with high accuracy, i.e. better than 1 % of the assumed mass of the coating. The test piece shall be immersed fully in the stripping solution at ambient temperature and left until the coating dissolves completely. A sufficient quantity of solution shall be used to limit any changes in the composition of the stripping solution.

After stripping, the test piece shall be rinsed under running water and, if necessary, brushed to remove any loose substances which may be adhering to the surface. It shall then be plunged into alcohol or any other appropriate solvent, rapidly dried, and once again weighed to the accuracy stipulated above.

The surface area of the exposed surface shall then be determined to an accuracy of 1 % by measuring the dimensions of the test piece.

5.2.1.3 Calculation of the coating mass per unit area

For the calculation of the coating mass per unit area, the following symbols are employed.

m_1 is the mass of the sample before chemical stripping, in grams (g);

m_2 is the mass of the sample after chemical stripping, in grams (g);

A is the coated surface area of the sample, in square millimetres (mm^2);

l is the length of the sample, in millimetres (mm);

d is the diameter of the chemically stripped wire (in case of round wire), in millimetres (mm);

Δm is the mass loss of the sample by the chemical stripping, in grams (g);

m_A is the coating mass per unit area, in grams per square metre (g/m^2).

The coating mass on the samples is:

$$\Delta m = m_1 - m_2$$

The coating mass per unit of surface area, in grams per square millimetre (g/mm^2), is:

$$m_A = \frac{\Delta m}{A}$$

Expressed in grams per square metre (g/m^2), this becomes:

$$m_A = \frac{\Delta m \times 10^6}{A} \quad (1)$$

For round wire, the surface area can be expressed as:

$$A = \pi \times d \times l \quad (2)$$

$$m_2 = \frac{\pi d^2}{4} \times l \times 7{,}85 \times 10^{-3} = (\pi \times d \times l)\, d \times 1{,}962 \times 10^{-3} \quad (3)$$

Combining (2) and (3) results in:

$$m_2 = A \times d \times 1{,}962 \times 10^{-3} \quad (4)$$

or

$$A = \frac{m_2}{1{,}962 \times d \times 10^{-3}} \quad (5)$$

Combining (1) and (5) results in:

$$m_A = \frac{\Delta m \times 10^6}{(m_2/1{,}962) \times d \times 10^{-3}} = \frac{\Delta m}{m_2} \times 10^3 \times d \times 1{,}962 = \frac{m_1 - m_2}{m_2} \times d \times 1\,962 \quad (6)$$

5.2.2 Other methods

Depending on the type of coating, other methods may be used to obtain the mass of the coating more simply and more quickly. The use of these methods is authorized under the following conditions: proof of the validity of the method shall be supplied and in the event of any dispute, only the gravimetric method shall apply.

5.3 Adherence test

If the wire diameter is less than or equal to 7,5 mm, the adherence of the coating shall be tested by wrapping the wire for at least six tight turns around a cylindrical mandrel. Wires of diameter greater than 7,5 mm shall undergo a bending test at an angle of at least 90° around the mandrel. Unless otherwise specified in a