INTERNATIONAL STANDARD

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Second edition
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Paints and varnishes — Corrosion protection of steel structures by protective paint systems —

Part 5: Protective paint systems

Peintures et vernis — Anticorrosion des structures en acier par systèmes de peinture —
Partie 5: Systèmes de peinture

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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 12944-5 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 14, *Protective paint systems for steel structures*.

This second edition cancels and replaces the first edition (ISO 12944-5:1998), which has been technically revised. The revision includes a reduction in the number of paint systems and in the number of tables. These changes have also brought about some changes in the numbering of the systems in the tables.

ISO 12944 consists of the following parts, under the general title *Paints and varnishes — Corrosion protection of steel structures by protective paint systems*:

— *Part 1: General introduction*

— *Part 2: Classification of environments*

— *Part 3: Design considerations*

— *Part 4: Types of surface and surface preparation*

— *Part 5: Protective paint systems*

— *Part 6: Laboratory performance test methods and associated assessment criteria*

— *Part 7: Execution and supervision of paint work*

— *Part 8: Development of specifications for new work and maintenance*

Introduction

Unprotected steel in the atmosphere, in water and in soil is subjected to corrosion that may lead to damage. Therefore, to avoid corrosion damage, steel structures are normally protected to withstand the corrosion stresses during the required service life of the structure.

There are different ways of protecting steel structures from corrosion. ISO 12944 deals with protection by paint systems and covers, in the various parts, all features that are important in achieving adequate corrosion protection. Other measures are possible, but require particular agreement between the interested parties.

In order to ensure effective corrosion protection of steel structures, it is necessary for owners of such structures, planners, consultants, companies carrying out corrosion protection work, inspectors of protective coatings and manufacturers of coating materials to have at their disposal state-of-the-art information in concise form on corrosion protection by paint systems. Such information has to be as complete as possible, unambiguous and easily understandable to avoid difficulties and misunderstandings between the parties concerned with the practical implementation of protection work.

This International Standard — ISO 12944 — is intended to give this information in the form of a series of instructions. It is written for those who have some technical knowledge. It is also assumed that the user of ISO 12944 is familiar with other relevant International Standards, in particular those dealing with surface preparation, as well as relevant national regulations.

Although ISO 12944 does not deal with financial and contractual questions, attention is drawn to the fact that, because of the considerable implications of inadequate corrosion protection, non-compliance with requirements and recommendations given in this standard might result in serious financial consequences.

ISO 12944-1 defines the overall scope of all parts of ISO 12944. It gives some basic terms and definitions and a general introduction to the other parts of ISO 12944. Furthermore, it includes a general statement on health, safety and environmental protection, and guidelines for using ISO 12944 for a given project.

ISO 12944-5 gives some terms and definitions related to paint systems in combination with guidance for the selection of different types of protective paint system.

Paints and varnishes — Corrosion protection of steel structures by protective paint systems —

Part 5: Protective paint systems

1 Scope

This part of ISO 12944 describes the types of paint and paint system commonly used for corrosion protection of steel structures. It also provides guidance for the selection of paint systems available for different environments (see ISO 12944-2) and different surface preparation grades (see ISO 12944-4), and the durability grade to be expected (see ISO 12944-1). The durability of paint systems is classified in terms of low, medium and high.

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

ISO 3549, *Zinc dust pigments for paints — Specifications and test methods*

ISO 4628-1, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 1: General introduction and designation system*

ISO 4628-2, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 2: Assessment of degree of blistering*

ISO 4628-3, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 3: Assessment of degree of rusting*

ISO 4628-4, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 4: Assessment of degree of cracking*

ISO 4628-5, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 5: Assessment of degree of flaking*

ISO 4628-6, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 6: Assessment of degree of chalking by tape method*

ISO 8501-1, *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*

ISO 8501-3, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 3: Preparation grades of welds, edges and other areas with surface imperfections*

ISO 12944-1, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 1: General introduction*

ISO 12944-2, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 2: Classification of environments*

ISO 12944-4:1998, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 4: Types of surface and surface preparation*

ISO 12944-6, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 6: Laboratory performance test methods and associated assessment criteria*

ISO 19840, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12944-1 and the following terms and definitions apply.

3.1
high-build
property of a coating material which permits the application of a coat of greater thickness than usually considered as normal for that type of coating

NOTE For the purposes of this part of ISO 12944, this means ⩾ 80 µm dry film thickness per coat.

3.2
high-solids
property of a coating material which contains a volume of solids greater than normal for that coating material

3.3
compatibility
⟨for products within a paint system⟩ ability of two or more products to be used together successfully as a paint system without causing undesirable effects

3.4
compatibility
⟨between a product and the substrate⟩ ability of a product to be applied to a substrate without causing undesirable effects

3.5
priming coat
first coat of a coating system

NOTE Priming coats provide good adhesion to sufficiently roughened, cleaned metal and/or cleaned old coating, ensuring a sound base for, and offering adhesion to, the subsequent coats. They normally also provide corrosion protection during the overcoating interval and the whole service life of the paint system.

3.6
intermediate coat
any coat between the priming coat and the finishing coat/topcoat

NOTE In the English language, the term “undercoat” is sometimes used synonymously, normally for a coat applied directly before the finishing coat/topcoat.

3.7
topcoat
final coat of a coating system

3.8
tie coat
coat designed to improve intercoat adhesion and/or avoid certain defects during application

3.9
stripe coat
supplementary coat applied to ensure uniform coverage of critical and difficult to coat areas such as edges, welds, etc.

3.10
dry film thickness
DFT
thickness of a coating remaining on the surface when the coating has hardened/cured

3.11
nominal dry film thickness
NDFT
dry film thickness specified for each coat or for the whole paint system

3.12
maximum dry film thickness
highest acceptable dry film thickness above which the performance of the paint or the paint system could be impaired

3.13
primer
paint that has been formulated for use as a priming coat on prepared surfaces

3.14
pre-fabrication primer
fast-drying paint that is applied to blast-cleaned steel to provide temporary protection during fabrication while still allowing welding and cutting

NOTE In many languages, the term pre-fabrication primer does not have the same meaning as in English.

3.15
pot life
maximum time, at any particular temperature, during which a coating material supplied as separate components can successfully be used after they have been mixed together

3.16
shelf life
time during which a coating material will remain in good condition when stored in its original sealed container under normal storage conditions

NOTE The expression “normal storage conditions” is usually understood to mean storage between +5 °C and +30 °C.

3.17
volatile organic compound
VOC
any organic liquid and/or solid that evaporates spontaneously at the prevailing temperature and pressure of the atmosphere with which it is in contact

4 Types of paint

4.1 General

For the protection of steel structures against corrosion many paint systems are widely used.

Based on the corrosivity category, various examples of anticorrosive paint systems are given, in relation to the expected durability, in Tables A.1 to A.8 in Annex A, which is informative in nature. The systems have been included because of their proven track record, but the list is **NOT** intended to be exhaustive and other similar systems are also available.

In addition, new technologies are continually being developed, often driven by government legislation, and these should always be considered where appropriate and where performance has been validated by:

a) the track record of such technologies and/or

b) the results of testing at least in accordance with ISO 12944-6.

NOTE 1 The information given in 4.2, 4.3 and 4.4 concerns only the chemical and physical properties of paints and not the way they are used. The limits given for drying and curing temperatures are only indicative. Variations can be expected for each type of paint, depending on its formulation.

For the purposes of application, paints can be classified as solvent-borne, water-borne or solvent-free. They are first divided into two main categories according to the manner in which they dry and cure (see 4.2 and 4.3) and then subdivided (see 4.3.2 to 4.3.5) by generic type and mechanism of cure.

NOTE 2 The main physical and mechanical properties are summarized in Annex C.

4.2 Reversible coatings

The film dries by solvent evaporation with no other change of form, i.e. the process is reversible and the film can be re-dissolved in the original solvent at any time.

Examples of binders in this type of coating material are:

a) chlorinated rubber (CR);

b) vinyl chloride copolymers (also known as PVC);

c) acrylic polymers (AY).

The drying time will depend, among other things, on air movement and temperature. Drying can take place down to 0 °C, although at low temperatures it is much slower.

4.3 Irreversible coatings

4.3.1 General considerations

The film dries initially by solvent evaporation (where a solvent is present) followed by a chemical reaction or by coalescence (in some water-borne paints). The process is irreversible, meaning that the film cannot be dissolved in the original solvent or, in the case of a solvent-free coating, in a solvent typically used with that generic type of paint.

4.3.2 Air-drying paints (oxidative curing)

In these paints, the film hardens/forms by evaporation of solvent, followed by reaction of the binder with oxygen from the atmosphere.

Typical binders are:

— alkyd;

— urethane alkyd;

— epoxy ester.

The drying time will depend, among other things, on the temperature. The reaction with oxygen can take place down to 0 °C, although at low temperatures it is much slower.

4.3.3 Water-borne paints (single pack)

In this type of paint, the binder is dispersed in water. The film hardens by evaporation of water and coalescence of the dispersed binder to form a film.

The process is irreversible, i.e. this type of coating is not re-dispersible in water after drying.

Binders which are typically dispersed in water are:

— acrylic polymers (AY);

— vinyl polymers (PVC);

— polyurethane resins (PUR).

The drying time will depend, among other things, on air movement, relative humidity and temperature. Drying can take place down to +3 °C, although at low temperatures it is much slower. High humidity (greater than 80 % RH) also impedes the drying process.

4.3.4 Chemically curing paints

4.3.4.1 General considerations

In general, this type of paint consists of a base component and a curing agent component. The mixture of base and curing agent has a limited pot life (see 3.15).

The paint film dries by evaporation of solvents, if present, and cures by a chemical reaction between the base and the curing agent components.

The types given below are commonly in use.

NOTE The base component and/or the curing agent component may be pigmented.

4.3.4.2 Epoxy 2-pack paints

4.3.4.2.1 Base component

The binders in the base component are polymers having epoxy groups, which react with suitable curing agents.

Typical binders are:

— epoxy;

— epoxy vinyl/epoxy acrylic;

— epoxy combinations (e.g. epoxy hydrocarbon resins);

Formulations can be solvent-borne, water-borne or solvent-free.

Most epoxy coatings chalk when exposed to sunlight. If colour or gloss retention is required, the topcoat should be an aliphatic polyurethane (see 4.3.4.3) or a suitable physically drying type (see 4.2) or water-borne (see 4.3.3).

4.3.4.2.2 Curing agent component

Polyaminoamines (polyamines), polyaminoamides (polyamides) or adducts of these are most commonly used.

Polyamides are more suitable for primers because of their good wetting properties. Polyamine-cured coatings are generally more resistant to chemicals.

The drying time will depend, amongst other things, on air movement and on the temperature. The curing reaction can take place down to + 5 °C, and lower for specialist products.

4.3.4.3 Polyurethane 2-pack paints

4.3.4.3.1 Base component

The binders are polymers with free hydroxyl groups which react with suitable isocyanate curing agents.

Typical binders are:

— polyester;

— acrylic;

— epoxy;

— polyether;

— fluoro resin;

— polyurethane combinations (e.g. polyurethane hydrocarbon resins) (PURC).

4.3.4.3.2 Curing agent component

Aromatic or aliphatic polyisocyanates are most commonly used.

Aliphatic-polyisocyanate-cured products (PUR, aliphatic) have excellent gloss-retention and colour-retention properties if combined with a suitable base component.

Aromatic-polyisocyanate-cured products (PUR, aromatic) give faster curing but are much less suitable for exterior exposure because they tend to chalk and discolour more rapidly.

The drying time will depend, among other things, on air movement and temperature. The curing reaction can take place down to 0 °C, or lower, but the relative humidity should be kept within the paint manufacturer's recommended range to ensure coatings are free from bubbles and/or pinholes.