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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.

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

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*
- *Part 7: Execution and supervision of paint work*
- *Part 8: Development of specifications for new work and maintenance*

Annexes A to C of this part of ISO 12944 are for information only.

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 service life required 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. Additional or 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 may 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.

This part of ISO 12944 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), surface preparation grades (see ISO 12944-4) and durabilities 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 standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 12944. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 12944 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 2808:1997 *Paints and varnishes - Determination of film thickness.*

ISO 3549:1995 *Zinc dust pigments for paints - Specifications and test methods.*

ISO 4628-1:1982 *Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect - Part 1: General principles and rating schemes*.

ISO 4628-2:1982 *Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect - Part 2: Designation of degree of blistering.*

ISO 4628-3:1982 *Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect - Part 3: Designation of degree of rusting.*

ISO 4628-4:1982 *Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect - Part 4: Designation of degree of cracking.*

ISO 4628-5:1982 *Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect - Part 5: Designation of degree of flaking.*

ISO 4628-6:1990 *Paints and varnishes - Evaluation of degradation of paint coatings - Designation of intensity, quantity and size of common types of defect - Part 6: Rating of degree of chalking by tape 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.*

ISO 8503-2:1988 *Preparation of steel substrates before application of paints and related products - Surface roughness characteristics of blast-cleaned steel substrates - Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel - Comparator procedure.*

ISO 12944-1:1998 *Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 1: General introduction.*

ISO 12944-2:1998 *Paints and varnishes - Corrosion protection of steel structures by protective paints 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 12944-6:1998 *Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 6: Laboratory performance test methods.*

3 DEFINITIONS

This clause covers those expressions which are used in this part of ISO 12944 and not covered by ISO 12944-1.

3.1 High-build

The 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. For the purposes of this part of ISO 12944, this means ≥80 µm dry film thickness.

3.2 High-solid

A term used to describe paint materials with a greater than normal volume of solids.

3.3 Compatibility

(I) of products in a paint system:
The ability of two or more products to be used in a paint system without causing undesirable effects.

(II) of a product with the substrate:
The ability of a product to be applied to a substrate without causing undesirable effects.

3.4 Priming coat(s)

The first coat(s) of a paint system, obtained by application of a primer.

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.

3.5 Intermediate coat(s)

Coat(s) between priming and top coat(s).

NOTE 1 In the English language, the term "undercoat" is sometimes used synonymously, normally for a coat applied directly before the top coat(s).

3.6 Top coat(s)

The last coat(s) of a paint system, designed to protect the coats beneath from the environment, to contribute to the overall corrosion protection offered by the system and to give the requisite colour.

3.7 Tie coat

A coat designed to improve intercoat adhesion and/or avoid certain defects during application.

3.8 Stripe coat

A supplementary coat applied to ensure adequate protection of critical areas like edges, welds etc.

3.9 Dry film thickness (DFT)

The thickness of a coating remaining on the surface when the coating has hardened.

3.10 Nominal dry film thickness (NDFT)

The dry film thickness specified for each coat or for the whole paint system to achieve the required durability.

3.11 Maximum dry film thickness

The highest acceptable dry film thickness above which the performance of the paint or the paint system may be impaired.

3.12 Primer

A paint that has been formulated for use as a priming coat on prepared surfaces, commonly under subsequent coats.

3.13 Pre-fabrication primer

A fast-drying paint that is applied to the blast-cleaned steel of a structure to protect the steel during fabrication while still allowing the steel to be welded.

NOTE 2 In many languages, the term pre-fabrication primer does not have the same meaning as in English.

3.14 Pot life

The maximum time during which a coating material supplied as separate components should be used after they have been mixed together.

3.15 Shelf life

The time during which a coating material will remain in good condition when stored in its original sealed containers under normal storage conditions.

NOTE 3 The expression "normal storage conditions" is usually understood to mean storage between +3 °C and +30 °C.

3.16 VOC (volatile organic compound)

Fundamentally, any organic liquid and/or solid that evaporates spontaneously at the prevailing temperature and pressure of the atmosphere with which it is in contact.

As to current usage of the term VOC in the field of coating materials see 3.17.

3.17 VOC content (volatile organic compound content/VOCC)

The mass of the volatile organic compounds present in a coating material, as determined under specified conditions.

NOTE 4 The exact interpretation of the word "volatile" will depend on the sphere of application of the coating material and the conditions at the place of application. For each sphere of application, the limiting values of the VOC content and the methods of determination or calculation are stipulated by regulations or by agreements.

4 TYPES OF PAINT

The following generic types of paint are widely used in paint systems for the protection of steel structures against corrosion. Typical binders for these paints are mentioned in the following sub-clauses. Many other modifications or combinations of them will also be possible.

NOTE 5 The information given hereafter 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 indicative only. Variations can be expected for each type of paint depending on its formulation.

4.1 Air drying paints

The film hardens by evaporation of organic solvents or water followed by reaction of the binder with oxygen in the air.

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.

4.2 Physically drying paints

Formulations of these paints can be solvent-borne or water-borne.

4.2.1 Solvent-borne paints

The film dries by evaporation of the solvents. The process is reversible, i.e. the dry film remains soluble in its original solvents.

Typical binders are:

– chlorinated rubber;
– vinyl chloride copolymers (also known as PVC);
– acrylic resins;
– bitumen.

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.

4.2.2 Water-borne paints

In these paints the binder is dispersed in water.

The film hardens by evaporation of water and film-forming (coalescence) of the dispersed binder.

The process is not reversible, i.e. this type of coating is not redispersible in water after drying.

Typical binders are:

– acrylic dispersions;
– vinyl dispersions;
– polyurethane dispersions.

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.

4.3 Chemically curing paints

In general, this type of paint consists of a base component and a curing agent component.

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

The types given in 4.3.1, 4.3.2 and 4.3.3 are in use.

4.3.1 Epoxy 2-pack paints

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 or epoxy coal tar).

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

Epoxies chalk when exposed to sunlight. If colour or gloss retention is required, the top coat should be an aliphatic polyurethane (4.3.2) or a suitable physically drying type (4.2).

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. Polyamines lead to coatings which are generally more resistant to chemicals.

Curing does not require exposure to air. 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.

4.3.2 Polyurethane 2-pack paints

Base component

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

Formulations can be solvent-borne or solvent-free.

Typical binders are:

– polyester;
– acrylate;
– epoxy;
– polyether;
– fluoro resin.

Curing agent component

Aromatic or aliphatic polyisocyanates are most commonly used.

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

Aromatic-polyisocyanate-curing agents give faster drying but are less suitable for exterior exposure, tending to chalk and discolour more rapidly.

Curing does not require exposure to air. However, 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 preferably be kept within the paint manufacturer's recommended range to ensure coatings free from bubbling and pinholing.

4.3.3 Moisture curing paints

The film dries by solvent evaporation. It cures chemically by reacting with moisture from the air.

Typical types are:

- polyurethane (1-pack);
- alkyl silicate, e.g.
- ethyl silicate (2-pack);
- ethyl silicate (1-pack).

The drying time will depend, amongst other things, on the temperature, the air movement, the humidity and the film thickness. The curing reaction can take place down to 0 °C, or lower, provided that the air still contains moisture. The lower the relative humidity, the slower the curing.

It is important that manufacturers instructions regarding the limits for moisture, relative humidity and wet and dry film thickness are complied with in order to avoid bubbling, pinholing, detachment etc. in the coating.

4.4 General properties of different generic types of paint

Further information is given in annex C. This informative annex is intended only as an aid to selection, but if it is used it shall be used in combination with the tables in annex A, manufacturers published data and information from previous projects.

5 PAINT SYSTEMS

5.1 Classification of environments and surfaces to be painted

5.1.1 Classification of environments

In accordance with ISO 12944-2 the environment is divided into the following categories:

Six atmospheric corrosivity categories
- C1 very low
- C2 low
- C3 medium
- C4 high
- C5-I very high (industrial)
- C5-M very high (marine)

Three categories for water and soil
- Im1 immersion in fresh water
- Im2 immersion in sea or brackish water
- Im3 buried in soil