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

Part 9:

**Protective paint systems and
laboratory performance test methods
for offshore and related structures**

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*Peintures et vernis — Anticorrosion des structures en acier par
systèmes de peinture —*

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*Partie 9: Systèmes de peinture protectrice et méthodes d'essai de
performance en laboratoire pour la protection des structures
offshore et structures associées*



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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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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. (standards.iteh.ai)

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This first edition of ISO 12944-9 cancels and replaces ISO 20340:2009, which has been technically revised.

A list of all parts in the ISO 12944 series can be found on the ISO website.

Introduction

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

There are different ways of protecting steel structures from corrosion. ISO 12944 (all parts) 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, owners of such structures, planners, consultants, companies carrying out corrosion protection work, inspectors of protective coatings and manufacturers of coating materials need to have at their disposal state-of-the-art information in concise form on corrosion protection by paint systems. It is vital that such information is as complete as possible, unambiguous and easily understandable to avoid difficulties and misunderstandings between the parties concerned with the practical implementation of protection work.

ISO 12944 (all parts) 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 (all parts) is familiar with other relevant International Standards, in particular those dealing with surface preparation.

Although ISO 12944 (all parts) 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 document may result in serious financial consequences.

ISO 12944-1 defines the overall scope 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 (all parts) for a given project.

Offshore and related structures require specific attention in order to be able to withstand the severe corrosion stresses to which they are exposed during their service life and to minimize the risk of failures that would impact safety, operating costs or capital cost.

In order to establish sufficient corrosion protection and ensure optimum performance of the coating, it is necessary to specify the requirements for the protective paint system(s) along with the relevant laboratory performance tests to assess its (their) likely durability.

In order to achieve the same performance as indicated by testing, proper surface preparation and application of the paint is essential. Close attention needs to be given to the execution of the work.

This document places emphasis on high-durability paint systems, with the aim of minimizing maintenance and hence reducing safety considerations and environmental impact.

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

Part 9:

Protective paint systems and laboratory performance test methods for offshore and related structures

1 Scope

This document specifies the performance requirements for protective paint systems for offshore and related structures (i.e. those exposed to the marine atmosphere, as well as those immersed in sea or brackish water). Such structures are exposed to environments of corrosivity category CX (offshore) and immersion category Im4 as defined in ISO 12944-2.

This part of ISO 12944 describes paint systems for high durability according to ISO 12944-1.

This document is applicable to structures made of carbon steel and does not cover Cd/Bi Cr and Zn/Bi Cr surfaces. It is not applicable to surfaces under insulation or concrete.

This document is applicable for paint systems intended for a service temperature range between $-20\text{ }^{\circ}\text{C}$ and $+80\text{ }^{\circ}\text{C}$, and the performance testing is aimed at verifying suitability of the paint systems for this temperature range.

This document is applicable for paint systems for submerged service (Im4) which are intended for ambient operating temperatures up to a maximum of $50\text{ }^{\circ}\text{C}$.

This document specifies:

- the test methods to be used to determine the composition of the separate components of the protective paint system;
- the laboratory performance test methods for the assessment of the likely durability of the protective paint system;
- the criteria to be used to evaluate the results of performance tests.

This document covers the requirements for new work and any repairs necessary before start-up. It can also be used in relation to maintenance where complete refurbishment is carried out and the underlying metal substrate is completely exposed by abrasive blast-cleaning.

It does not address maintenance in general where methods of surface preparation other than abrasive blast-cleaning are typically used.

This document deals with structures, made of carbon steel of not less than 3 mm thickness, which are designed using an approved strength calculation.

The following are not covered by this document:

- structures built of stainless steel as well as those built of copper, titanium or aluminium or their alloys;
- steel cables;
- buried structures;
- pipelines;

— the interiors of storage tanks.

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 1461, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods*

ISO 1514, *Paints and varnishes — Standard panels for testing*

ISO 2063 (all parts), *Thermal spraying — Zinc, aluminium and their alloys*

ISO 2811 (all parts), *Paints and varnishes — Determination of density*

ISO 2812-2, *Paints and varnishes — Determination of resistance to liquids — Part 2: Water immersion method*

ISO 3233-1, *Paints and varnishes — Determination of the percentage volume of non-volatile matter — Part 1: Method using a coated test panel to determine non-volatile matter and to determine dry film density by the Archimedes principle*

ISO 3251, *Paints, varnishes and plastics — Determination of non-volatile-matter content*

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

ISO 4624, *Paints and varnishes — Pull-off test for adhesion*

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*

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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 8503-1, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 1: Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast-cleaned surfaces*

ISO 8503-2, *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 9117-3, *Paints and varnishes — Drying tests — Part 3: Surface-drying test using ballotini*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

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

ISO 12944-5, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 5: Protective paint systems*

ISO 15711:2003, *Paints and varnishes — Determination of resistance to cathodic disbonding of coatings exposed to sea water*

ISO 16474-3:2013, *Paints and varnishes — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps*

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*

ISO 29601, *Paints and varnishes — Corrosion protection by protective paint systems — Assessment of porosity in a dry film*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12944-1, ISO 12944-5, ISO 1461, ISO 2063 (all parts) and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

offshore and related structures

permanently installed or moored structures with high requirements for long-term integrity

Note 1 to entry: Typical examples are oil and gas production facilities.

3.2

product technical-data sheet

product TDS

document designed to provide information on a specific paint product

Note 1 to entry: The type of information typically includes product uses, features, service properties, application properties, application instructions, packaging information and information on storage and handling.

Note 2 to entry: See 6.4 for specifically required minimum information.

3.3

safety data sheet

SDS

document designed to provide information regarding the health and safety aspects of a paint product or thinner

Note 1 to entry: The SDS typically includes information concerning generic material identification, hazardous ingredients, physical data, fire and explosion data, health hazards, reactivity data, spill or leak procedures, special protection requirements and other special precautions.

3.4 qualification

process for the evaluation of protective paint systems using test criteria which allow the selection of suitable paint systems for distinct environmental exposure conditions

Note 1 to entry: The process comprises:

- description of the paint system (for an example, see [Table 2](#));
- application testing (see [Clause 8](#));
- laboratory performance testing and assessment of the results (see [Clause 9](#));
- full identification of the paints (see [6.5.2](#) and [Annex C](#)).

3.5 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

Note 1 to entry: Under US Government legislation, the term VOC is restricted solely to those compounds that are photochemically active in the atmosphere (see ASTM D3960). Any other compound is then defined as being an exempt compound.

3.6 splash and tidal zones

areas that are alternately wet and dry because of the influence of tides, winds and/or waves or ballasting/loading

3.7 holding primer

fast-drying primer that is applied to blast-cleaned carbon steel to protect it during fabrication of a structure, but does not allow the carbon steel to be welded

Note 1 to entry: Primers which do allow the carbon steel to be welded are called “pre-fabrication primers”.

4 Field of application

4.1 Type of environment

This document deals with the atmospheric corrosivity category CX (offshore) for operating temperature and the immersion category Im4 as defined in ISO 12944-2.

The structure may be divided into different zones based on the type of environment each zone is exposed to:

- one zone corresponds to the area exposed to atmospheric category CX (offshore);
- another zone corresponds to the area that is permanently immersed in sea water, i.e. category Im4;
- two further zones correspond to the tidal and splash zones which are a combination of category CX (offshore) and Im4:
 - the tidal zone is the area in which the water level changes because of natural or artificial effects, thus giving rise to increased corrosion due to the combined effect of cyclic exposure to water and the atmosphere;
 - the splash zone is the area wetted by wave and spray action which can give rise to exceptionally high corrosion stresses, especially with sea water.

In this document, the splash and tidal zones are combined for qualification purposes into one set of tests (see [Table 3](#)).

4.2 Type of surface and surface preparation

This document deals with the following types of surface (more information is given in ISO 12944-4):

- uncoated carbon steel surfaces;
- metal-coated surfaces (thermal-sprayed metallic coating or hot-dip galvanized steel);
- surfaces painted with pre-fabrication primer;
- previously painted surfaces from which the existing paint system has been completely removed.

Except for metal-coated surfaces, surface preparation shall be by blast cleaning to preparation grade Sa 2½ (minimum) as defined in ISO 8501-1 and to surface profile “medium (G)” as defined in ISO 8503-1.

For surface preparation before and after application of the thermal-sprayed metallic coating, see ISO 2063 (all parts).

Hot-dip galvanized steel shall be sweep blasted in accordance with ISO 12944-4.

4.3 Type of paint

The generic types of paint widely used in paint systems for the protection of carbon steel structures against corrosion are described in ISO 12944-5, but are not limited to those in ISO 12944-5.

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5 Relationship between artificial ageing and natural exposure

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The selection of a paint system for a specific situation should preferably be based on experience from the use of the system in similar cases. The reason is that the durability of a paint system depends on many external factors such as the environment, the design of the structure, the surface preparation, and the application and drying procedures.

The durability is of course also linked to the chemical and physical characteristics of the system, e.g. the type of binder and the dry-film thickness. The influence of these characteristics on the durability can be evaluated by artificial-ageing tests. Of primary interest is resistance to water or moisture, and to salt fog, as an indication of wet adhesion and the barrier properties. The ageing tests and durations specified hereafter have been selected to ensure, with a high probability, that paint systems really do have the characteristics needed for the durability required in the intended application.

However, results from artificial-ageing tests shall be used with caution. It shall be clearly understood that artificial ageing will not necessarily have the same effect as natural exposure. Many factors have an influence on the progress of degradation and, in the laboratory, it is not possible to accelerate all of them in the proper way. It is therefore difficult to make a reliable ranking of paint systems of very different compositions from artificial-ageing tests in the laboratory. This can sometimes lead to efficient protective paint systems being rejected because they cannot pass these tests. It is recommended that natural-exposure trials always be undertaken so that, in the long term, such anomalies can be resolved.

6 Paints

6.1 General

The performance of protective paint systems shall be tested in accordance with [Clause 9](#) and the separate components of the system (the paints) shall be identified in accordance with [6.5](#)

For each paint in the paint system, the manufacturer shall provide a product technical-data sheet (product TDS) (see [6.4](#)) and a safety data sheet (SDS).

Neither the chemical composition of the individual paints in the paint system (see 6.5.2 and 6.5.3) nor the description of the paint system (see 7.1) shall be changed after qualification.

6.2 Quality assurance

The paint manufacturer shall set up and maintain a quality assurance system such as is necessary to ensure that the goods or services supplied comply in all respects with the requirements of this document.

6.3 Packaging and labelling

All coating materials, solvents and thinners shall be stored in their original container bearing the manufacturer's label and instructions. At least the following information shall be shown on the label:

- the name of the coating material;
- the curing component;
- the name of the paint manufacturer;
- the colour of the coating material;
- the batch number;
- the date of manufacture;
- instructions and warnings regarding health, safety and environmental protection in accordance with applicable regulations;
- a reference to the relevant product TDS.

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6.4 Required product information

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At least the following information, in addition to that in the SDS, shall be provided in the product TDS with each product submitted to qualification testing:

- the date of issue;
- the name of the product;
- the name of the manufacturer;
- the generic name for the paint;
- the generic name for the curing agent;
- the generic name for each additional component;
- the colour of the coating material;
- the mixing ratio;
- the mixing instructions (including any induction time);
- the shelf life under the recommended storage conditions;
- the non-volatile matter by volume of the mixed product (determined in accordance with ISO 3233-1)¹⁾;
- the density of the mixed product (determined in accordance with the appropriate part of ISO 2811)¹⁾;
- the pot life of the mixed product¹⁾;

1) These values shall be obtained at (23 ± 2) °C and (50 ± 5) % RH or as otherwise agreed.