INTERNATIONAL STANDARD

ISO 20340

Second edition
2009-04-01

Paints and varnishes — Performance requirements for protective paint systems for offshore and related structures

Peintures et vernis — Exigences de performance relatives aux systèmes de peinture pour la protection des structures offshore et structures associées

Reference number
ISO 20340:2009(E)

Contents

Page

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 20340 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 20340:2003), which has been technically revised.

Introduction

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 application of the paint is essential. Close attention needs to be given to the execution of the work.

In ISO 12944, relevant requirements are given for:

— atmospheric-corrosivity categories (Part 2);

— suitable design properties (Part 3);

— type of surface and surface preparation (Part 4);

— application of the paint and the execution and supervision of the paint work during the construction and installation of the structure (Part 7);

— development of a specification (Part 8).

This International Standard (ISO 20340) covers the requirements for new work and any repairs necessary before start-up. It may 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 (see 4.4).

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

Paints and varnishes — Performance requirements for protective paint systems for offshore and related structures

1 Scope

1.1 This International Standard deals with 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 C5-M and immersion category Im2 as defined in ISO 12944-2, with special stresses as given in Subclause 4.3 and Annex B of ISO 12944-2:1998. ISO 20340 can also be used for other structures, provided that the paints or protective paint systems selected comply with this International Standard.

This International Standard places emphasis on high-durability paint systems, with the aim of minimizing maintenance and hence reducing safety considerations and environmental impact. It specifies additional test requirements over and above those specified for corrosivity category C5-M in ISO 12944-6. Hence, a system fulfilling the requirements for C5-M high durability in ISO 12944-6 will not necessarily fulfil the requirements of this International Standard and might thus need further testing to do so.

The temperature range applicable for these paint systems is normally between −20 °C and +80 °C, and the performance testing is aimed at verifying suitability of the paint systems for this temperature range. The use of paint systems outside this temperature range shall be subject to agreement by the end user. Such agreement may include testing at the applicable temperatures.

The paint systems for submerged service (Im2) are aimed at ambient operating temperatures up to a maximum of 50 °C. For higher operating temperatures, specific evaluation and performance documentation is needed. The selection of performance requirements should be considered in conjunction with the cathodic-protection design parameters.

1.2 This International Standard includes:

— 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.

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 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 1517, *Paints and varnishes — Surface-drying test — Ballotini method*[1)]

ISO 2063, *Thermal spraying — Metallic and other inorganic coatings — 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, *Paints and varnishes — Determination of percentage volume of non-volatile matter by measuring the density of a dried coating*

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

ISO 3679, *Determination of flash point — Rapid equilibrium closed cup method*

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

ISO 4628 (Parts 2 to 6), *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance*

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

ISO 11507:2007, *Paints and varnishes — Exposure of coatings to artificial weathering — Exposure to fluorescent UV lamps and water*

ISO 12944-2:1998, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 2: Classification of environments*

ISO 12944-3, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 3: Design considerations*

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*

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1) Under revision as ISO 9117-3.

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

ISO 12944-7, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 7: Execution and supervision of paint work*

ISO 12944-8, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 8: Development of specifications for new work and maintenance*

ISO 14680-2, *Paints and varnishes — Determination of pigment content — Part 2: Ashing method*

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

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 following terms and definitions apply.

3.1
offshore and related structures
permanently installed or moored structures with high requirements for long-term integrity

NOTE Typical examples are oil and gas production facilities.

3.2
coat
continuous layer of a coating material resulting from a single application

3.3
corrosion
physicochemical interaction between a metal and its environment that results in changes in the properties of the metal and that can often lead to impairment of the function of the metal, the environment or the technical system of which these form a part

3.4
durability
expected life of a protective paint system to the first major maintenance painting

3.5
paint
pigmented coating material in liquid, paste or powder form that, when applied to a substrate, forms an opaque film having protective, decorative or specific technical properties

3.6
protective coating system
sum total of the coats of metal materials and/or paints or related products that are to be applied, or which have been applied, to a substrate to provide corrosion protection

3.7
protective paint system
sum total of the coats of paints or related products that are to be applied, or have been applied, to a substrate to provide corrosion protection

3.8
substrate
surface to which a coating material is applied or is to be applied

3.9
nominal dry film thickness
NDFT
dry film thickness specified for each coat or for the whole coating system

3.10
dry film thickness
DFT
thickness of a coat or coating system remaining on the surface after hardening

NOTE The DFT is measured in accordance with ISO 19840.

3.11
product technical-data sheet
product TDS
document designed to provide information on a specific paint product

NOTE 1 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 See 5.4 for specifically required minimum information.

3.12
material safety data sheet
MSDS
document designed to provide information regarding the health and safety aspects of a paint product or thinner

NOTE The MSDS 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.

3.13
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 The process comprises:

— description of the paint system (for an example, see Table 2);

— application testing (see Clause 7);

— laboratory performance testing and assessment of the results (see Clause 8);

— full identification of the paints (see Subclause 5.5.2 and Annex B).

3.14
shelf life
period from the date of manufacture during which the paint can be transported and stored in undamaged and unopened packaging without any influence on its application or performance providing the ambient conditions are within the limits recommended by the paint manufacturer

NOTE 1 After exceeding this period, the paint is subject to re-inspection.

NOTE 2 Water-borne products have to be protected from freezing at all times during transportation and storage.

3.15
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 Under U.S. government legislation, the term VOC is restricted solely to those compounds that are photochemically active in the atmosphere (see ASTM D 3960). Any other compound is then defined as being an exempt compound.

3.16
splash and tidal zones
areas that are alternately wet and dry because of the influence of tides, winds and/or waves or ballasting/loading

3.17
holding primer
fast-drying primer that is applied to blast-cleaned steel to protect it during fabrication of a structure, but does not allow the steel to be welded

NOTE Primers which do allow the steel to be welded are called “pre-fabrication primers”.

4 Field of application

4.1 General

The field of application for which this International Standard has been developed is characterized by

— the type of structure;

— the type of environment;

— the type of surface and surface preparation;

— the type of paint.

4.2 Type of structure

This International Standard deals with structures, made of carbon or low-alloy steel of not less than 3 mm thickness, which are designed using an approved strength calculation.

Not covered by this International Standard are:

— 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.

4.3 Type of environment

This International Standard deals with the atmospheric corrosivity category C5-M and the immersion category Im2 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 C5-M.

— Another zone corresponds to the area that is permanently immersed in sea water, i.e. category Im2.

— Two further zones correspond to the tidal and splash zones which are a combination of category C5-M and Im2:

  — 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 International Standard, the splash and tidal zones are combined for qualification purposes into one set of tests (see Table 3).

4.4 Type of surface and surface preparation

This International Standard deals with the following types of carbon or low-alloy steel surface (more information is given in ISO 12944-4):

— uncoated surfaces;

— metal-coated surfaces (thermally sprayed or hot-dip galvanized);

— 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 or Sa 3 as defined in ISO 8501-1 and to surface profile “medium (G)” as defined in ISO 8503-1.

4.5 Type of paint

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

5 Paints

5.1 General

The performance of protective paint systems shall be tested in accordance with Clause 8 and the separate components of the system (the paints) shall be identified in accordance with Subclause 5.5

Should third-party certification be requested, an independent laboratory shall be agreed on between the interested parties.

For each paint layer in the paint system, the manufacturer shall provide a product technical-data sheet (product TDS) (see Subclause 5.4) and a material safety data sheet (MSDS).

Neither the chemical composition of the individual paints in the paint system (see Subclauses 5.5.2 and 5.5.3) nor the description of the paint system (see Subclause 6.1) shall be changed after qualification.

5.2 Quality assurance

The paint manufacturer shall set up and maintain a quality assurance system (see ISO 12944-8) such as is necessary to ensure that the goods or services supplied comply in all respects with the requirements of this International Standard.

5.3 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.

5.4 Required product information

At least the following information, in addition to that in the MSDS, 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)[2)];

— the density of the mixed product (determined in accordance with the appropriate part of ISO 2811)[2)];

— the pot life of the mixed product[2)];

— the flash point of each separate product (determined in accordance with ISO 3679);

— the time taken for the surface of the coating to dry (determined in accordance with ISO 1517)[2)];

— the time to full cure[2)];

— the recommended thinner(s) (name and/or No.);

— the flash point(s) of the recommended thinner(s);

— the maximum quantity of each thinner allowed for application;

— the recommended surface preparation grade (see ISO 8501-1) and profile (see ISO 8503-1);

— the recommended method of application;

— the minimum and maximum over-coating time;

— the recommended minimum and maximum dry film thickness;

— the solvent recommended for cleaning the equipment;

— the recommended application conditions (temperature and relative humidity);

— the maximum VOC content and the method to be used to check that it is not exceeded[3)];

— a reference to the MSDS;

— the theoretical spreading rate (in m^2/l or m^2/kg for a dry film thickness of x µm).

5.5 Paint identification

5.5.1 General

Each paint in a paint system shall be subjected to two types of identification check:

a) A fingerprint check (see 5.5.2) shall be carried out on all the paints of the paint system submitted to qualification testing.

b) A routine batch check (see 5.5.3) shall be carried out initially and on every subsequent batch of the paints in a qualified paint system.

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

3) For details, see the MSDS.

5.5.2 Fingerprint check

The aim of a fingerprint check is to confirm the consistency of the paints supplied with reference to qualified paints. After qualification of a paint system, this fingerprint may be used, if necessary, to verify that the paints supplied are identical to those subjected to qualification testing.

The fingerprint shall include at least the parameters given in Annex B.

5.5.3 Routine batch check

The results of a routine batch check, using simple laboratory techniques, can show differences in the composition of a paint by comparison with the sample(s) subjected to qualification testing.

The paint manufacturer shall carry out a routine batch check on each batch of paint. Such checks are subject to documentation forming part of the paint manufacturer‘s quality assurance system and are used to provide the certificate of conformity, if required by the purchaser.

The minimum data required for a simple identification check (if relevant to the product in question) are given in Table 1.

Table 1 — Routine batch check (batch by batch, final product inspection)

Date of issue		Production date	
Name of paint		Product TDS No.	
Batch number		MSDS No.	

	Test method	Test result	Specification with tolerance
Density	Appropriate part of ISO 2811	.....	..... g/cm^3 $\pm$ 0,05 g/cm^3 [a]
Non-volatile matter by mass	ISO 3251	.....	..... % $\pm$ 2 %

[a] For densities greater than 2 g/cm^3, the relevant tolerance is $\pm$ 0,1 g/cm^3.

Each of the interested parties shall be entitled to carry out additional checks on any batch to verify the fingerprint.

5.6 Confidential information

This International Standard describes an assessment process for protective paint systems for which confidential information has to be supplied by the paint manufacturer. Such information, and the detailed results of the assessment process, shall be the property of the purchaser but shall not be disseminated by the purchaser without prior agreement from the paint manufacturer.

6 Protective paint systems

6.1 Description

A protective paint system subject to qualification shall be described by:

a) The name and address of the manufacturer.

b) The type of environment (see 4.3) and the type of substrate (see 4.4) that the paint system is designed for.

c) The surface preparation recommended for the substrate (method and resultant grade).

d) The product designation for each coat in the paint system in the order of application. The following information is required for each product:

— the trade name;

— the generic name of the paint;

— the colour range;

— the nominal dry film thickness (NDFT).

The NDFT of the protective paint system is the sum of the NDFTs of each individual coat.

An example of a paint system description is given in Table 2.

Table 2 — Example of a paint system description

Manufacturer		**Type of substrate**		**Type of environment**
Name: Address:				
Surface preparation				
	Trade name	**Colour range**	**Generic type**	**NDFT** (µm)
1st coat				
2nd coat				
3rd coat				
4th coat				
etc.				
			Total NDFT (µm):	

6.2 Minimum requirements for protective paint systems

Paint systems that pass all the tests in this International Standard are likely to provide offshore coatings with high durability. However, there are many factors that can influence the actual performance and durability of a coating.

Experience has shown that one of the parameters which is essential for the achievement of high durability in practice is the coating system make-up, primarily the number of coats and the total dry film thickness.

For this reason, this International Standard establishes a set of minimum requirements for the coating systems for the various environmental zones.

It should be emphasized, however, that the paint systems given in Table 3 are made up of different generic coating types: primer, intermediate coat and topcoat. They should therefore only be considered as minimum requirements. In addition, the list is not intended to be comprehensive.

In special cases, coating systems based on fewer coats can be relevant. However, in such cases, this shall be accompanied by a significant increase in total dry film thickness compared to the minimum requirements in Table 3, and it is advisable to take special quality control measures during application.

If a holding primer is used, thus becoming part of the coating system (as an extra layer), this shall be agreed between the interested parties and the holding primer qualified in accordance with this International Standard.

Table 3 — Minimum requirements for protective paint systems and their initial performance

Substrate	Blast-cleaned carbon steel: Sa 2½ or Sa 3; Surface profile: medium (G)							Hot-dip-galvanized steel or steel with Zn-based metallizing [a]
Corrosivity category of environment	C5-M		Splash and tidal zones C5-M and Im2			Im2		C5-M
First coat	Zn (R)[b]	Other primers[c]	Zn (R)[b,d]	Other primers[c]		Other primers		
NDFT (µm)	⩾ 40	⩾ 60	⩾ 40	⩾ 60	⩾ 200	—	⩾ 150	
Minimum number of coats [e]	3	3	3	3	2	1	2	2
NDFT of paint system (µm)	⩾ 280	⩾ 350	⩾ 450	⩾ 450	⩾ 600	⩾ 800	⩾ 350	⩾ 200
Minimum pull-off test value (before ageing) determined in accordance with ISO 4624 (MPa)	3	4	3	4	4	8	4	3

[a] The thickness of the metallic coating shall be in accordance with ISO 1461 (hot-dip galvanized) or ISO 2063 (metallized steel) and the coating shall be prepared as specified in ISO 12944-4:1998, Clause 12 (hot-dip galvanized) or Clause 13 (metallized steel). Overcoating of thermally sprayed aluminium (TSA) is not recommended due to the risk of the overcoat flaking and corrosion of the TSA occurring. For TSA, a sealer coat only is recommended.

[b] Zn (R) = Zinc-rich primer as defined in ISO 12944-5:2007, Subclause 5.2 (minimum 80 % by mass of zinc dust in the non-volatile part of the paint). The zinc dust pigment shall conform to ISO 3549.

[c] The use of primers other than Zn (R) is mainly applicable to repair and maintenance. For new constructions, the use of other primers should be restricted to areas subjected to special stresses (as defined in ISO 12944-2:1998, Annex B, Clause B.2), where the need for a coating system with higher mechanical strength or higher chemical resistance outweighs the better rust creep protection offered by Zn (R) primers. Examples of areas subject to special stresses are helicopter decks, splash and tidal zones, walkways, escape routes, material lay-down areas and mud zones.

[d] This coating system with an organic Zn (R) primer can also be used for Im2 service if a Zn (R) primer is desired. In this case, the NDFT of the complete system can be reduced to ⩾ 350.

[e] The number of coats does not include a tie coat, which might be needed when a Zn (R) silicate primer is used, for instance.

7 Application testing of paints

7.1 Paints sampled for application testing shall not exhibit any hard skin, grains or sediment in its original packaging. It shall be easy to stir. The product shall be tested within its shelf life and pot life.

7.2 Each paint used in the paint system shall show no sign of running or sagging when applied at a dry film thickness equal to at least 1,5 times the specified NDFT to a smooth, degreased vertical plate with an area of 1 m^2.

NOTE For primers and self-priming products, it is recommended that a blasted steel plate with a “medium (G)” profile be used instead of a smooth plate.

8 Performance testing of the paint system

8.1 Preparation and conditioning of test panels

8.1.1 Type and size of panel and number of panels

Test panels shall be made from steel complying with ISO 1514. Unless agreed otherwise, the minimum size of the panels shall be 150 mm × 75 mm × 3 mm. If the thickness of the panels is less than 5 mm, the “sandwich” method of pull-off testing specified in ISO 4624 is recommended. Three panels shall be prepared for each test.

8.1.2 Surface preparation

Degrease the test panels using a suitable method and grit-blast them to at least Sa 2½ as defined in ISO 8501-1. Unless agreed otherwise, the surface profile of the test side of each panel shall correspond to “medium (G)” as defined in ISO 8503-1 and shall be checked with a comparator using the method specified in ISO 8503-2.

Other methods of surface preparation may be used to represent actual field conditions, as agreed between the interested parties.

The test panels shall be dry and free of dust and any other foreign matter.

All parameters related to surface preparation (cleanliness, roughness, dust level, etc.) shall be recorded as part of the test report.

8.1.3 Application and curing

Coat the panels by spraying in strict accordance with the manufacturer's written instructions. Cure in accordance with the paint manufacturer's written instructions.

Protect the backs and edges of the test panels using an appropriate method agreed on between the interested parties.

8.1.4 Dry film thickness

For each coat, prior to over-coating, measure the DFT on the test face of the panel in accordance with ISO 19840 at five locations (centre and each corner, 15 mm to 20 mm from the panel edge) and record these measurements as the minimum, mean and maximum (see Annex C, Clause C.1).

The maximum thickness of each coat on each panel shall be

— less than 1,5 × the NDFT if the NDFT is $\leqslant$ 60 µm;

— less than 1,25 × the NDFT if the NDFT is $>$ 60 µm.

8.1.5 Over-coating time

For each coat, carry out over-coating in accordance with the paint manufacturer's most recent instructions.

Deviations from the over-coating time specified by the paint manufacturer shall be agreed between the interested parties and recorded in the test report.

8.1.6 Conditioning/curing

Condition the panels at controlled temperature and humidity in accordance with ISO 3270. If curing and conditioning are conducted under different conditions, they shall be clearly stated in the test report.

The coating system shall be fully cured in accordance with the manufacturer's most recent instructions before testing starts.

The test conditions shall be agreed on between the interested parties or be in accordance with the paint manufacturer’s instructions.

8.1.7 Porosity detection

In order to avoid premature failure, carry out a suitable test to detect the presence of any pinholes in the coating.

8.1.8 Scribe line

When specified in Table 4, a scribe line (see Figures 1 and 2) shall be made in the paint coating on each test panel to ensure full exposure to all the elements of the test. The scribe line shall be made mechanically (with a machine such as a drill press with cobalt slot drills). It shall be 50 mm long, 2 mm wide, 12,5 mm from each long edge of the panel and 25 mm from one of the short edges of the panel. It shall cut completely through the paint coating and into the metal substrate.

8.1.9 Recording of data

Record all relevant data measured during the preparation of the test panels (see Annex C).

Dimensions in millimetres

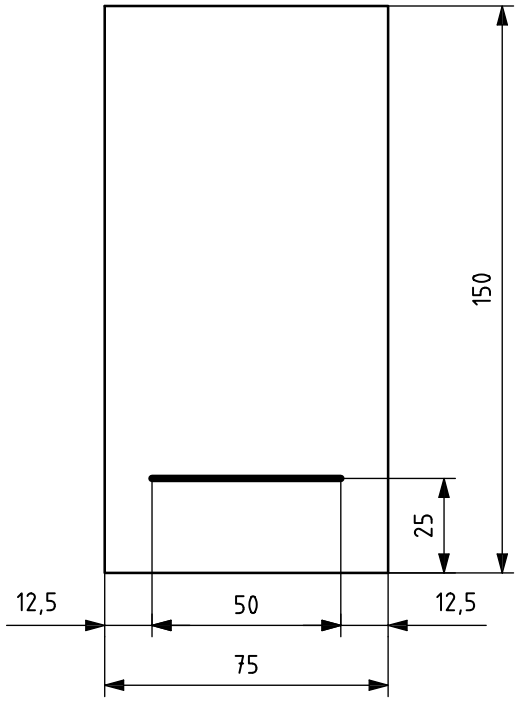
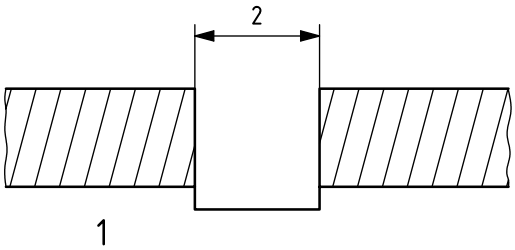


Figure 1 — Test panel showing position of scribe line

Dimensions in millimetres



Key

1 steel substrate

Figure 2 — Cross-section of scribe line

8.2 Qualification tests

Carry out the qualification tests given in Table 4.

Optional tests may also be carried out, such as chemical resistance, impact resistance, abrasion resistance and thick film cracking resistance. The actual optional tests to be carried out shall be agreed between the interested parties.

Table 4 — Qualification tests

Test	Scribe line	Environment of corrosivity category C5-M	Environment of combined corrosivity category C5-M and Im2 (splash and tidal zones)	Environment of corrosivity category Im2
Ageing resistance (see Annex A)	Yes (see 8.1.8)	4 200 h	4 200 h	—
Cathodic disbonding (ISO 15711:2003, method A, unless otherwise agreed)	No (artificial holiday used instead — see Table 5)	—	4 200 h	4 200 h
Sea water immersion (ISO 2812-2)	Yes (see 8.1.8)	—	4 200 h	4 200 h

8.3 Assessment: methods and requirements

8.3.1 General

Assess the test panels in accordance with ISO 12944-6. Methods and requirements are given in Table 5. Two out of the three panels shall meet the requirements.

Any paint defect which develops within 10 mm of the edges of the test panel shall not be taken into account.

8.3.2 Assessment of corrosion from a scribe line

After removing the coating by a suitable method, measure the width of the corrosion at nine points (the midpoint of the scribe line and four other points, 5 mm apart, on each side of the midpoint). Calculate the corrosion creep M from the equation $M = (C - W)/2$, where C is the average of the nine width measurements and W is the original width of the scribe.

Table 5 — Assessment of test panels — Methods and requirements (ISO 12944-6)

Assessment method	Requirement before qualification testing	Requirement after qualification testing	
ISO 4624 (pull-off test)	See Table 3. No adhesive failure between the substrate and the first coat unless the pull-off value is 5 MPa or more (see ISO 12944-6).	Assessment after 2 weeks' reconditioning. Minimum pull-off = 50 % of original value measured on the test panel, with a minimum value of 2 MPa. No adhesive failure between the substrate and the first coat unless pull-off value is 5 MPa or more (see ISO 12944-6).	
ISO 4628-2 (blistering)		0 (S0)	Carry out assessment immediately after the qualification test
ISO 4628-3 (rusting)		Ri 0	Carry out assessment immediately after the qualification test
ISO 4628-4 (cracking)		0 (S0)	Carry out assessment immediately after the qualification test
ISO 4628-5 (flaking)		0 (S0)	Carry out assessment immediately after the qualification test
ISO 4628-6 (chalking)		If agreed between the interested parties	
Corrosion from a scribe line (see 8.1.8 and 8.3.2)		$M \leqslant$ 3,0 mm for coating system with Zn (R) primer $M \leqslant$ 8,0 mm for coating system with primer other than Zn (R)	
Cathodic disbonding in accordance with ISO 15711:2003, method A		Immediately before the qualification test, form an artificial holiday (steel substrate totally exposed) of diameter 6 mm, using the procedure specified in method A of ISO 15711:2003. After the qualification test, use a sharp, thin-bladed knife to make two radial cuts at 45° to each other through the coating, intersecting at the centre of the holiday. Cut the coating down to the steel substrate. Attempt to lift the coating with the point of the knife. Record the total area now exposed (including the area of the holiday). Calculate the disbonded area as the difference between the total area exposed and the area of the holiday. From the disbonded area, calculate the corresponding equivalent diameter. The equivalent diameter of the disbonded area shall be not more than 20 mm.	

9 Test report

The test report shall contain at least the following information:

a) the test laboratory (name and address);

b) the date(s) of the tests;

c) all details necessary for complete identification of the protective paint system (see 6.1) including fingerprint data;

d) the type of environment in which the protective paint system is to be used (see 4.3) and the qualification tests carried out (see 8.2);

e) a description of the preparation and conditioning of the test panels (see 8.1);

f) the results of the assessment of the test panels before ageing (see Clause 7 and Table 5);

g) the results of the assessment of the test panels after ageing for each qualification test (see Tables 4 and 5);

h) any deviation from the specified test methods.

An example of a test report form is given in Annex C.

Annex A
(normative)

Ageing procedure

The exposure cycle used in this procedure lasts a full week (168 h) and includes:

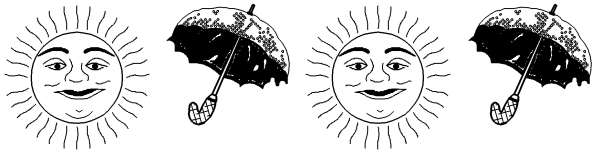
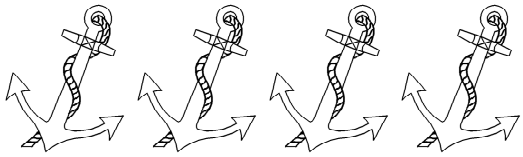
a) 72 h of exposure to UV and condensation in accordance with ISO 11507:2007 under the following conditions:

   — method A of ISO 11507:2007: alternating periods of 4 h exposure to UV at (60 ± 3) °C and 4 h exposure to condensation at (50 ± 3) °C,

   — type II UV lamps (UVA-340) — see ISO 11507:2007, Subclause 5.1.2;

b) 72 h of exposure to salt spray in accordance with ISO 9227;

c) 24 h of exposure to low temperature at (−20 ± 2) °C.

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
UV/condensation — ISO 11507			Salt spray — ISO 9227			Low-temp. exposure at (–20 ± 2) °C
						

Start the UV/condensation period with UV exposure and finish with condensation.

Between the salt spray and low-temperature periods, rinse the panels with deionized water but do not dry them.

At the beginning of the low-temperature period, the panel shall reach the temperature of (−20 ± 2) °C within 30 min.

Expose the test panels for 25 cycles or 4 200 h.

Annex B
(normative)

Fingerprint

Date of issue:		Base material	Curing agent
Name of paint			
Name of manufacturer			
Batch number			
Production date			
	Test method	**Test result range**	**Test result range**
Main parameters[a]			
Infrared spectra	See Bibliography		
Non-volatile matter (by mass)	ISO 3251	(.... ± 2) %	(.... ± 2) %
Density	Appropriate part of ISO 2811	(.... ± 0,05) g/cm^3	(.... ± 0,05) g/cm^3
Ash	See Bibliography	(.... ± 3) %	(.... ± 3) %
Optional parameters *			
Pigment content (by mass) — Zn metal/Total Zn	ISO 14680-2	(.... ± 1) %	(.... ± 1) %
Pigment content (by mass) — Al	ISO 14680-2	(.... ± 1) %	(.... ± 1) %
Pigment content (by mass) — Fe	ISO 14680-2	(.... ± 1) %	(.... ± 1) %
Pigment content (by mass) — P	ISO 14680-2	(.... ± 1) %	(.... ± 1) %
Content of functional groups — Epoxy	See Bibliography		
Content of functional groups — OH	See Bibliography		
Content of functional groups — Acidic	See Bibliography		
Content of functional groups — Amine	See Bibliography		
Content of functional groups — Isocyanate	See Bibliography		

[a] The results obtained will vary depending on colour shade.

The binder properties (infrared spectra and content of functional groups) shall be determined after separation of the resin from the pigment and the solvent.

Many other additional tests could be useful in characterizing more precisely the components of paint.

Annex C
(informative)

Examples of test reports

C.1 Example of test report for preparation of test panels

Laboratory: **ISO 20340:2009**

Laboratory	Dates of tests
Name: Address:	End of panel preparation: Beginning of testing:

Description of paint system

Manufacturer	Type of environment	Type of substrate
Name: Address:		

Surface preparation:	

	Trade name	Colour range	Generic type	NDFT µm
1st coat				
2nd coat				
3rd coat				
4th coat				
etc.				
			Total	

Preparation of test panels

Substrate:	Surface preparation:	
Length, width and thickness:	Cleanliness:	Roughness:

Application of paint system					
	Trade name	Batch number	Temp. °C	RH %	Ease of application and method of application used (comments)
1st coat					
2nd coat					
3rd coat					
4th coat					

Thickness measurements and allocation of panels to tests													
NDFT	1st coat		2nd coat			3rd coat			4th coat				
Panel No.	Coating thickness measurements (min./mean/max.) (µm)												Test allocation

Drying/curing conditions:

Comments:

Date of report and signatures:

C.2 Example of test report for assessment of test panels after immersion in sea water in accordance with ISO 2812-2

Assessment before qualification tests									
	Panel No.			Panel No.			Panel No.		
	Individual	Mean	Pass/Fail	Individual	Mean	Pass/Fail	Individual	Mean	Pass/Fail
ISO 4624 (MPa)									
Comments:									
Assessment after water immersion (4 200 h)									
	Panel No.			Panel No.			Panel No.		
	Individual	Mean	Pass/Fail	Individual	Mean	Pass/Fail	Individual	Mean	Pass/Fail
ISO 4624 (MPa)									
ISO 4628-2									
ISO 4628-3									
ISO 4628-4									
ISO 4628-5									
ISO 4628-6									
Rusting: spread from scribe line (M, in mm)									
Comments:									

Date of report and signatures:

C.3 Example of test report for assessment of test panels after exposure testing

Exposure cycle (see Annex A):

Assessment before qualification testing									
	Panel No.			Panel No.			Panel No.		
	Individual	Mean	Pass/Fail	Individual	Mean	Pass/Fail	Individual	Mean	Pass/Fail
ISO 4624 (MPa)									
Comments:									
Assessment after exposure testing (4 200 h)									
	Panel No.			Panel No.			Panel No.		
	Individual	Mean	Pass/Fail	Individual	Mean	Pass/Fail	Individual	Mean	Pass/Fail
ISO 4624 (MPa)									
ISO 4628-2									
ISO 4628-3									
ISO 4628-4									
ISO 4628-5									
ISO 4628-6									
Rusting: spread from scribe line (M, in mm)									
Comments:									

Date of report and signatures:

Bibliography

Terminology

[1] ISO 8044, *Corrosion of metals and alloys — Basic terms and definitions*

[2] ISO 4618, *Paints and varnishes — Terms and definitions*

Determination of ash (by mass)

[3] NF T30-012, *Paints — Determination of ash content in varnishes, paints and similar products*

Determination of binder and extender content (by mass)

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

Determination of content of functional groups

[5] **Isocyanate content:** ISO 11909, *Binders for paints and varnishes — Polyisocyanate resins — General methods of test*

[6] **Hydroxyl value:** ISO 4629, *Binders for paints and varnishes — Determination of hydroxyl value — Titrimetric method*

[7] **Epoxy value:** ISO 7142, *Binders for paints and varnishes — Epoxy resins — General methods of test*

[8] **Amine content:** ISO 11908, *Binders for paints and varnishes — Amino resins — General methods of test*

Pigment content

[9] **Aluminium:** ISO 1247, *Aluminium pigments for paints*

[10] **Iron oxide (red oxide):** ISO 1248, *Iron oxide pigments — Specifications and methods of test*

[11] **Micaceous iron ore:** ISO 10601, *Micaceous iron oxide pigments for paints — Specifications and test methods*

[12] **Zinc dust:** ISO 3549, *Zinc dust pigments for paints — Specifications and test methods*

[13] **Zinc phosphate:** ISO 6745, *Zinc phosphate pigments for paints — Specifications and methods of test*

IR spectra

[14] ASTM D 2372, *Standard Practice for Separation of Vehicle from Solvent-Reducible Paints*

[15] ASTM D 2621, *Standard Test Method for Infrared Identification of Vehicle Solids from Solvent-Reducible Paints*

Others

[16] ISO 2114, *Plastics (polyester resins) and paints and varnishes (binders) — Determination of partial acid value and total acid value*

[17] ASTM D 3960, *Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings*

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