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

Part 4: Types of surface and surface preparation

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

Partie 4: Types de surface et de préparation de surface

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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.

This document 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 12944-4:1998), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the terms and definitions which were not used in the main part of the standard have been deleted;

— the normative references have been updated;

— 5.6 “Surfaces with chemical treatment” has been included;

— 6.2.8 “Chemical treatment” has been included;

— Annex C has been restructured to contain two tables for distinction between “extraneous layers and foreign matter” and “native layers and contaminants”;

— the bibliography has been updated;

— the text has been editorially revised.

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

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Introduction

Unprotected steel in the atmosphere, in water and in soil is subjected 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 ISO 12944 (all parts) can 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.

This document describes the different types of surface to be protected and gives information on surface preparation methods such as chemical and mechanical cleaning. It deals with surface preparation grades, surface profile (roughness), assessment of prepared surfaces, temporary protection of prepared surfaces, preparation of temporarily protected surfaces for further coatings, preparation of existing metal coatings, and environmental aspects. As far as possible, reference is made to the basic International Standards on the surface preparation of steel substrates before application of paints and related products.

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

Part 4: Types of surface and surface preparation

1 Scope

This document covers the following types of surfaces of steel structures consisting of carbon or low-alloy steel, and their preparation:

— uncoated surfaces;

— surfaces thermally sprayed with zinc, aluminium or their alloys;

— hot-dip-galvanized surfaces;

— zinc-electroplated surfaces;

— sherardized surfaces;

— surfaces painted with prefabrication primer;

— other painted surfaces.

This document defines a number of surface preparation grades but does not specify any requirements for the condition of the substrate prior to surface preparation.

Highly polished surfaces and work-hardened surfaces are not covered by this document.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 2063 (all parts), *Thermal spraying — Zinc, aluminium and their alloys*

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*

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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 8501-1:2007, *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 8501-2:1994, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 2: Preparation grades of previously coated steel substrates after localized 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 8501-4, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 4: Initial surface conditions, preparation grades and flash rust grades in connection with high-pressure water jetting*

ISO 8504 (all parts), *Preparation of steel substrates before application of paints and related products — Surface preparation methods*

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

ISO 16276 (all parts), *Corrosion protection of steel structures by protective paint systems — Assessment of, and acceptance criteria for, the adhesion/cohesion (fracture strength) of a coating*

EN 10238, *Automatically blast-cleaned and automatically prefabrication primed structural steel products*

3 Terms and definitions

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

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

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
abrasive blast-cleaning
impingement of a high-kinetic-energy stream of *blast-cleaning abrasive* (3.2) on to the surface to be prepared

[SOURCE: ISO 11124-1:1993, 2.2]

3.2
blast-cleaning abrasive
solid material intended to be used for *abrasive blast-cleaning* (3.1)

[SOURCE: ISO 11124-1:1993, 2.1]

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3.3
dust
loose particulate matter present on a steel surface prepared for painting, arising from *blast-cleaning* (3.1) or other surface preparation processes, or resulting from the action of the environment

[SOURCE: ISO 8502-3:2017, 3.1]

3.4
dew point
temperature at which moisture in the air will condense out on to a solid surface

Note 1 to entry: See ISO 8502-4.

3.5
flash rusting
slight rust formation on a prepared steel surface soon after preparation

3.6
grit
particles that are predominantly angular, that have fractured faces and sharp edges and that are less than half-round in shape

[SOURCE: ISO 11124-1:1993, 2.4]

3.7
mill scale
heavy oxide layer formed during hot fabrication or heat treatment of steel

3.8
rust
visible corrosion products consisting, in the case of ferrous metals, mainly of hydrated iron oxides

3.9
shot
particles that are predominantly round, that have a length of less than twice the maximum particle width and that do not have edges, broken faces or other sharp surface defects

[SOURCE: ISO 11124-1:1993, 2.3]

3.10
substrate
surface to which a coating material is applied or is to be applied

[SOURCE: ISO 4618:2014, 2.244]

3.11
surface preparation
method of preparing a surface for coating

3.12
white rust
white to dark grey corrosion products on zinc-coated surfaces

3.13
chemical treatment
surface treatment process, based on a chemical or electrochemical reaction, which superficially modifies the metal *substrate* (3.10)

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4 General

The primary objective of surface preparation is to ensure the removal of matter which negatively affects the corrosion protection and to obtain a surface that permits satisfactory adhesion of the coating to the surface. It will also assist in reducing the amounts of contaminants that initiate corrosion.

It is stressed that there is a very wide variation in the condition of steel surfaces requiring cleaning prior to painting. This particularly applies to maintenance of an already coated structure. The age of the structure and its location, the quality of the previous surface, the performance of the existing coating system and the extent of breakdown, the type and severity of previous and future corrosion environments, and the intended new coating system, all influence the amount of preparation required.

When selecting a surface preparation method, it is necessary to consider the preparation grade (according to this document) required to give a level of surface cleanliness and, if required, a surface profile (roughness) appropriate to the coating system to be applied to the steel surface.

Personnel carrying out surface preparation work shall have suitable equipment and sufficient technical knowledge of the processes involved to enable them to carry out the work in accordance with the required specification. It is important that the surfaces to be treated are readily accessible and sufficiently illuminated. All surface preparation work shall be properly supervised and inspected.

If the specified preparation grade has not been achieved by the preparation method selected or when the condition of the prepared surface has subsequently changed before the application of the coating system, relevant parts of the procedure shall be repeated so as to obtain the specified preparation grade.

Details regarding the preliminary treatment of welds, the removal of weld spatter and removal of burrs and other sharp edges shall be in accordance with ISO 8501-3. Details are given in ISO 12944-3. These measures should normally be taken in connection with the manufacturing process before the surface preparation.

NOTE For further details, see ISO 8504-1.

5 Types of surface to be prepared

5.1 General

The different types of surface shall be prepared as described in 5.2 to 5.6.

5.2 Uncoated surfaces

Uncoated surfaces consist of bare steel, which can be covered by mill scale or rust and other contaminants. They shall be assessed in accordance with ISO 8501-1 (rust grades A, B, C and D).

5.3 Metal-coated surfaces

5.3.1 Thermally sprayed surfaces

Thermally sprayed surfaces consist of steel coated with zinc, aluminium or their alloys by flame or arc spraying in accordance with ISO 2063 (all parts).

5.3.2 Hot-dip-galvanized surfaces

Hot-dip-galvanized surfaces consist of steel coated with zinc or zinc alloy by immersion in a molten bath in accordance with ISO 1461.

5.3.3 Zinc-electroplated surfaces

Zinc-electroplated surfaces consist of steel coated with an electrodeposited zinc coating.

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5.3.4 Sherardized surfaces

Sherardized surfaces consist of steel coated with zinc-iron alloy layers obtained by heating the steel component in a container together with zinc dust.

5.4 Surfaces painted with prefabrication primer

Surfaces painted with prefabrication primer consist of automatically blast-cleaned steel to which a prefabrication primer has been applied automatically in a plant, in accordance with EN 10238.

NOTE For the purpose of this document, the expression "surfaces painted with prefabrication primer" has a restricted meaning, as defined in EN 10238. It is restricted to automatic blast-cleaning and automatic priming.

5.5 Other painted surfaces

Other painted surfaces consist of steel/metal-coated steel that has already been painted (see 7.5).

5.6 Surfaces with chemical treatment

In some specific uses, chemical treatments are implemented to enhance corrosion resistance and/or to improve paint bonding, before metal painting operations.

With regard to this document, chemical treatment refers to hot-dip-galvanized steel surfaces, electroplated-zinc steel surfaces and sherardized surfaces.

Chemical treatment includes a dedicated cleaning followed by the chemical treatment itself conducted by spray, runoff or immersion, usually ending with a final step of rinsing.

The paint manufacturer shall previously confirm compatibility of the paint system with the chemical pre-treatment.

6 Surface preparation methods

6.1 General

The use of the methods described in 6.2 and 6.3 requires surface preparation, in accordance with ISO 8504 (all parts). Oil, grease, salts, dirt and similar contaminants shall be removed after agreement between the involved parties, prior to further surface preparation, using an appropriate method. In addition, prior removal of heavy, firmly adhering rust and mill scale by suitable manual or mechanical techniques can be necessary. Where metal-coated steel is to be cleaned, the technique shall not unnecessarily remove sound metal. A survey of cleaning methods is given in Annex C. The different methods listed are not exhaustive.

6.2 Water, solvent and chemical cleaning

6.2.1 Water cleaning

This method consists of directing a jet of clean, fresh water on to the surface to be cleaned. The water pressure required depends on the contaminants to be removed such as water-soluble materials, loose rust and poorly adhering paint coatings. To remove oil, grease, etc., the addition of suitable detergents is necessary. When detergents have been used in the cleaning operation, rinsing with clean, fresh water is necessary.

6.2.2 Steam cleaning

Steam cleaning is carried out to remove oil, grease, salts, dirt and similar contaminants. If a detergent is added to the steam, rinsing with clean, fresh water is necessary.

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6.2.3 Emulsion cleaning

Emulsion cleaning is carried out to remove oil, grease, salts, dirt and similar contaminants using emulsion cleaners, followed by rinsing with clean, fresh (hot or cold) water.

6.2.4 Alkaline cleaning

Alkaline cleaning is carried out to remove oil, grease, salts, dirt and similar contaminants by using alkaline cleaners, followed by rinsing using clean, fresh (hot or cold) water.

6.2.5 Organic-solvent cleaning

Organic-solvent cleaning is carried out to remove grease or oil by using suitable organic solvents. Degreasing with rags impregnated with organic solvent is usually restricted to small areas.

6.2.6 Stripping

Stripping is the removal of paint coatings by solvent-borne pastes (for coatings soluble in solvents) or alkaline pastes (for saponifiable coatings). It is normally restricted to small areas. Appropriate subsequent cleaning is necessary.

6.2.7 Acid pickling

Acid pickling (Be) involves immersion of the component in a bath containing a suitable inhibited acid which removes mill scale and rust. The exposed surface shall not be appreciably attacked.

Acid pickling is only suitable for use under carefully monitored factory conditions and is not normally a site process.

6.2.8 Chemical treatment

The quality of the surface treatment shall be assessed in accordance with the specifications of the surface treatment supplier before being processed to the paint application.

After complete chemical pre-treatment, the surface provided is deemed ready to use for painting. The work piece surfaces shall be completely dry and clean. If relevant, specific attention shall be paid to the maximum recovery time allowed to start the painting process, according to the recommendations of the surface treatment supplier.

6.3 Mechanical cleaning

6.3.1 Hand-tool cleaning

Typical hand tools include wire brushes, spatulas, scrapers, synthetic-fabric pads with embedded abrasives, emery cloth and rust-chipping hammers. For further details, see ISO 8504-3.

6.3.2 Power-tool cleaning

Typical power tools include rotating wire brushes, various types of grinder, percussion hammers and needle guns. Surface areas that cannot be reached with such tools shall be prepared by hand. The cleaning operation shall not cause any damage or deformation of the structural elements and care shall be taken to avoid the type of surface damage that chipping tools are liable to cause (notching). When wire brushes are used, it shall be ensured that rust and contaminants are not merely polished. Polished rust and mill scale can develop a sheen that looks like clean metal, but which would impair the adhesion of any coating applied to it. Cleaning with power tools is more effective in terms of area covered and degree of cleanliness than manual surface preparation, but is not nearly as effective as blast-cleaning. This should be borne in mind in those cases where power-tool cleaning is preferred to blast-cleaning

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(e.g. where the generation of dust or the accumulation of used abrasive is to be avoided). For further details, see ISO 8504-3.

6.3.3 Blast-cleaning

One of the methods specified in ISO 8504-2 shall be used. Blast-cleaning abrasives shall be specified by reference to the various parts of ISO 11124 and ISO 11126.

6.3.3.1 Dry abrasive blast-cleaning

6.3.3.1.1 Centrifugal abrasive blast-cleaning

Centrifugal abrasive blast-cleaning is carried out in fixed installations or mobile units in which the abrasive is fed to rotating wheels or impellers positioned to throw the abrasive evenly and at high velocity on to the surfaces to be cleaned.

For the fields of application, effectiveness and limitations of this technique, see ISO 8504-2.

6.3.3.1.2 Compressed-air abrasive blast-cleaning

Compressed-air abrasive blast-cleaning is carried out by feeding the abrasive into an air stream and directing the air/abrasive mixture at high velocity from the nozzle on to the surface to be cleaned.

The abrasive can be injected into the air stream from a pressurized container or can be drawn into the air stream by suction from an unpressurized container.

For the field of application, effectiveness and limitations of this technique, see ISO 8504-2.

6.3.3.1.3 Vacuum or suction-head abrasive blast-cleaning

This method is similar to compressed-air abrasive blast-cleaning (see 6.3.3.1.2) but with the blast nozzle enclosed in a suction head sealed to the steel surface, collecting the spent abrasive and contaminants. Alternatively, the air/abrasive stream can be sucked on to the surface by reduced pressure at the suction head.

For the field of application, effectiveness and limitations of this technique, see ISO 8504-2.

6.3.3.2 Moisture-injection abrasive blast-cleaning (compressed-air moisture-injection abrasive blast-cleaning)

This method is similar to compressed-air abrasive blast-cleaning (see 6.3.3.1.2) but with the addition of a very small amount of liquid (usually clean, fresh water), upstream of the nozzle, to the air/abrasive stream, resulting in a blast-cleaning procedure which is dust-free in the suspended-particle size range of less than 50 µm. The consumption of water can be controlled and is usually 15 l/h to 25 l/h.

For the field of application, effectiveness and limitations of this technique, see ISO 8504-2.

6.3.3.3 Wet abrasive blast-cleaning

6.3.3.3.1 Compressed-air wet abrasive blast-cleaning

This method is similar to compressed-air abrasive blast-cleaning (see 6.3.3.1.2) but with the addition of liquid (generally clean, fresh water) to produce a stream of air, water and abrasive.

For the field of application, effectiveness and limitations of this technique, see ISO 8504-2.

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6.3.3.3.2 Slurry blast-cleaning

A dispersion of fine abrasive in water or another liquid is directed, with pumps or compressed air, on to the surface to be cleaned.

For the field of application, effectiveness and limitations of this technique, see ISO 8504-2.

6.3.3.3.3 Pressurized-liquid blast-cleaning

An abrasive (or a mixture of abrasives) is introduced into a stream of liquid (generally clean, fresh water) and the stream directed through a nozzle on to the surface.

The stream is predominantly pressurized liquid, and additions of solid abrasives are normally less than for compressed-air wet abrasive blast-cleaning.

The abrasive can be introduced either as dry (with or without air) or as wet slurry.

For the field of application, effectiveness and limitations of this technique, see ISO 8504-2.

6.3.3.4 Particular applications of blast-cleaning

6.3.3.4.1 Sweep blast-cleaning

The aim of sweep blast-cleaning is to clean or roughen organic and metallic coatings on the surface only, or to remove a surface layer (or a poorly adhering coating) in such a way that a firmly adhering coating under it is neither pitted by particle impact nor stripped down to the substrate. The required surface condition shall be agreed between the interested parties. For this purpose, a test area can be prepared and assessed, and the various blast-cleaning parameters, e.g. hardness of abrasive, attack angle, distance from nozzle to substrate, air pressure and particle size of abrasive, can be optimized. Normally for sweep blast-cleaning, low air pressure and fine-grained, grit blast-cleaning abrasive is used.

6.3.3.4.2 Spot blast-cleaning

Spot blast-cleaning is a common form of compressed-air or moisture-injection blast-cleaning in which only individual stains (e.g. rust or weld spots) in an otherwise intact coating are blast-cleaned. It can be carried out in conjunction with sweep blast-cleaning of the other surfaces where these cannot be recoated without prior cleaning. Depending on the intensity of the blast-cleaning, the result will then be equivalent to preparation grade P Sa 2 or P Sa 2 1/2.

6.3.4 Water jetting

This method consists in directing a jet of pressurized clean, fresh water on to the surface to be cleaned. The water pressure depends on the contaminants to be removed, such as water-soluble matter, loose rust and poorly adhering paint coatings. When detergents have been used in the cleaning operation, rinsing with clean, fresh water is necessary. High-pressure water jetting and ultra-high-pressure water jetting shall be in accordance with ISO 8501-4.

7 Surface preparation grades

7.1 General

Requirements shall be based on the preparation grades listed in Annexes A and B.

Other preparation grades can be agreed on the basis of representative photographic examples or reference areas on the surface of the structure or component. Reference areas shall be effectively protected from any influences which might alter their appearance (e.g. by covering them with plastic sheeting), or they shall be photographed as representative examples.

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There are two types of surface preparation.

— Primary (overall) surface preparation (preparation of the whole surface to the bare steel).

  This type of surface preparation consists of removing mill scale, rust, existing coatings and contaminants. After primary surface preparation, the whole surface consists of bare steel.

  Preparation grades: Sa, St and Be.

— Secondary (partial) surface preparation (leaving sound parts of organic and metal coatings)

  This type of surface preparation consists of removing rust and contaminants, but leaving intact paint or metallic coatings.

  Preparation grades: P Sa, P St and P Ma.

Before application of paints and related products, a wet blast-cleaned surface can be required to dry. Where flash rusting occurs on a prepared surface, it can be necessary to remove this, if it is considered to be detrimental to the subsequent coating.

ISO 8501-1 gives preparation grades Sa 1, Sa 2, Sa 2 1/2, Sa 3 for blast-cleaning and St 2, St 3 for hand- and power-tool cleaning.

ISO 8501-1:2007, Annex A contains photographic examples of the change in appearance imparted to steel when blast-cleaned with different abrasives (high-carbon-steel shot, steel grit, chilled-iron grit, copper refinery slag, coal furnace slag).

7.2 Uncoated surfaces

The final appearance of the prepared steel surface depends on the initial surface condition (e.g. rust grades A to D) and the surface preparation method used. The various rust grades and surface preparation grades are described in ISO 8501-1 and in Annex A.

7.3 Metal-coated surfaces

If the metal coating (thermally sprayed, hot-dip-galvanized, zinc-electroplated or sherardized) needs to be removed completely down to the substrate, the grades defined in ISO 8501-1 are applicable.

If sound areas of metal coating remain, a “secondary (partial) surface preparation” is carried out. The grades cannot be referred to existing standards.

7.4 Surfaces painted with prefabrication primer

If a prefabrication primer needs to be removed completely back to the substrate, the grades defined in ISO 8501-1 are applicable.

If areas of prefabrication primer remain, a “secondary surface preparation” is carried out. Definitions of suitable preparation grades are given in ISO 8501-2 and in some of the documents listed in the bibliography.

7.5 Other painted surfaces

The surface to be prepared shall be assessed in accordance with ISO 4628-1, ISO 4628-2, ISO 4628-3, ISO 4628-4, ISO 4628-5 and ISO 4628-6 (degree of blistering rusting, cracking, flaking and chalking). Adhesion shall be assessed according to ISO 16276.

Isolated areas of coating failure with rust (spot rusting) on previously painted steel can be prepared by spot blast-cleaning. Care shall be taken that the surrounding sound areas are not damaged.

If the whole coating needs to be removed completely down to the steel, the grades defined in ISO 8501-1 are applicable.

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If the paint needs to be removed completely down to a metal coating, a "secondary surface preparation" is carried out. The grades cannot be referred to existing standards.

If areas of the paint coating remain, a "secondary surface preparation" is carried out. For areas with residual paint coatings and bare steel, the grades are defined by using the definitions of P grades. ISO 8501-2 gives preparation grades P Sa 2, P Sa 2 1/2, and P Sa 3 for localized blast-cleaning, P St 2 and P St 3 for localized hand- and power-tool cleaning and P Ma for localized machine abrading.

8 Surface profile (roughness) and surface profile grading

ISO 8503-1 specifies the requirements for ISO surface profile comparators (comparator S and comparator G) which are intended for visual and tactile comparison of steel substrates that have been blast-cleaned with either shot (S) abrasives or grit (G) abrasives.

The method for the grading of blast-cleaned surfaces using the ISO comparators specified in ISO 8503-1 is described in ISO 8503-2. The grading of blast-cleaned surfaces can also be done in accordance with ISO 8503-5.

The surface profile of the substrates influences the adhesion of the coating. For protective paint systems, a surface profile "medium (G)" or "medium (S)", as defined in ISO 8503-1, is particularly suitable. In the field of application of this document, it is not necessary to specify closer surface profile tolerances or particular surface profile values, but they can be agreed between the interested parties.

9 Assessment of prepared surfaces

Before applying the coating, the prepared surfaces shall be assessed in accordance with ISO 8501-1 or ISO 8501-2. Further methods for assessing the prepared surfaces may be agreed on by the contractual parties in individual cases. Such methods are specified in the different parts of ISO 8502.

10 Temporary protection of prepared surfaces from corrosion and/or contamination

Temporary protection of the prepared surface shall be used if the preparation grade is likely to change (e.g. by formation of rust) before the intended coating (primer or complete coating system) can be applied. This also applies to areas on which no coating is to be applied.

Prefabrication primers, adhesive paper, adhesive film, strippable varnishes and other protective materials that can be removed are commonly used for temporary protection. Before final coating, the surface will require further preparation until the specified surface condition is achieved.

11 Preparation of temporarily or partly protected surfaces before application of further coatings

It can be necessary to remove existing coatings or to roughen the surface by sweep blast-cleaning or by other suitable methods, followed by dust removal, to ensure proper adhesion of the subsequent coating. Joints and damaged areas of priming coats shall be re-cleaned and repaired after assembly.

Before further coating, all contamination and all corrosion and weathering products that have been formed in the meantime shall be removed by suitable means.

For blast-cleaned and primed prefabrication and shop-primed steel surfaces, the remaining priming coat can be a part of the complete paint system, provided that this is agreed by the interested parties and that the surface profile (roughness) is defined. If a priming coat is not in a condition suitable for repairing or further coating, or is not compatible with further coatings, it shall be completely removed.

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12 Preparation of hot-dip-galvanized surfaces

12.1 Unweathered surfaces

Defective areas in, or damage to, the zinc surface shall be repaired so that the protective properties of the zinc coating are fulfilled. Contamination of unweathered hot-dip-galvanized surfaces, e.g. by grease, oil, residual flux or marking materials, shall be removed.

The zinc coating may be treated by sweep blast-cleaning (see 6.3.3.4.1) using a non-metallic abrasive. Other treatment shall be in accordance with the specification.

After sweep blast-cleaning, the zinc coating shall be continuous and free from mechanical damage. The galvanized surfaces shall be free from adhering and enclosed contaminants that would impair the durability of the zinc coating and subsequently applied paint systems.

Examples of irregularities in the zinc coating are

— runs or overthick areas,

— pinholes,

— lack of adhesion between the zinc and the steel,

— zinc drips, and

— zinc ash.

After sweep blast-cleaning, the surface shall have a uniform dull appearance. The surface roughness and the minimum zinc coating retained shall be agreed between the interested parties.

12.2 Weathered surfaces

On weathered hot-dip-galvanized surfaces, zinc corrosion products (white rust) are formed and contaminants can accumulate. Such surfaces shall be prepared by suitable methods selected depending on the nature and extent of the contamination. Oxidation products, certain salts and some other contaminants can be removed by washing with clean, fresh water containing detergent and by using synthetic-fabric pads with embedded abrasive, followed by thorough cleaning with hot water. Alternatively, the methods specified in Clause 6 can be suitable.

13 Preparation of thermally sprayed metal (zinc and aluminium) surfaces

Defective areas in, or damage to, thermally sprayed metal coatings shall be repaired so that the protective power of the metal coating is restored.

To extend the service life of the coating, thermally sprayed metal coatings shall be painted immediately after thermal spraying before any condensation can take place.

NOTE For further information on thermally sprayed metal coatings, see ISO 2063 (all parts).

14 Preparation of zinc-electroplated and sherardized surfaces

Defective areas in, or damage to, zinc-electroplated or sherardized surfaces shall be repaired so that the protective properties of the zinc coating are fulfilled. Poorly adhering zinc-electroplated and sherardized coatings shall be removed.

Contamination on zinc-electroplated and sherardized surfaces, e.g. by grease, oil, marking materials or salts, shall be removed. Cleaning with special detergents, hot water or steam or by surface conversion (see 6.2.6) can be suitable.

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Subsequent painting of zinc-electroplated components will require the same treatment as hot-dip-galvanized surfaces (see Clause 12).

15 Preparation of other coated surfaces

Poorly adhering and defective coatings shall be removed.

Defective areas in, or damage to, the surface shall be repaired so that the protective properties of the protective coating system are fulfilled.

Afterwards, the surface can be treated by sweep blast-cleaning using an inert grit or any other material which can be demonstrated to be suitable (see Clause 11).

16 Recommendations regarding pollution and the environment

Pollution caused by surface preparation is normally covered by national safety and environmental regulations. If such regulations do not exist, special care shall be taken regarding industrial wastes, dust, noise, odours, organic solvents, etc.

Waste (such as used abrasives, rust, old coatings) shall be collected and treated in accordance with relevant national regulations and as agreed between the interested parties.

17 Health and safety

See ISO 12944-1.

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Annex A
(normative)

Standard preparation grades for primary (overall) surface preparation

Table A.1 — Standard preparation grades for primary (overall) surface preparation

Standard preparation grade[a]	Surface preparation method	Representative photographic examples in ISO 8501-1[b,c,d]	Essential features of prepared surfaces [For further details, including treatment prior to and after surface preparation (column 2), see ISO 8501-1.]	Field of application
Sa 1	Blast- cleaning (6.3.3)	B Sa 1 C Sa 1 D Sa 1	Poorly adhering mill scale, rust and paint coatings and foreign matter are removed[e].	The surface preparation of: a) uncoated steel surfaces; b) coated steel surfaces, if the coatings are removed to the extent that the specified preparation grade is achieved[f].
Sa 2		B Sa 2 C Sa 2 D Sa 2	Most of the mill scale, rust, paint coatings and foreign matter is removed. Any residual contamination shall be firmly adhering.	
Sa 2 1/2		A Sa 2 1/2 B Sa 2 1/2 C Sa 2 1/2 D Sa 2 1/2	Mill scale, rust, paint coatings and foreign matter are removed. Any remaining traces of contamination shall show only as slight stains in the form of spots or stripes.	
Sa 3[g]		A Sa 3 B Sa 3 C Sa 3 D Sa 3	Mill scale, rust, paint coatings and foreign matter are removed. The surface shall have a uniform metallic colour.	
St 2	Hand- or power-tool cleaning (6.3.1, 6.3.2)	B St 2 C St 2 D St 2	Poorly adhering mill scale, rust, paint coatings and foreign matter are removed[e].	
St 3		B St 3 C St 3 D St 3	Poorly adhering mill scale, rust, paint coatings and foreign matter are removed[e]. However, the surface shall be treated much more thoroughly than for St 2 to give a metallic sheen arising from the metal substrate.	—

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Table A.1 *(continued)*

Standard preparation grade[a]	Surface preparation method	Representative photographic examples in ISO 8501-1[b,c,d]	Essential features of prepared surfaces [For further details, including treatment prior to and after surface preparation (column 2), see ISO 8501-1.]	Field of application
Be	Acid pickling (6.2.7)	—	Mill scale, rust and residues from paint coatings are removed completely. Paint coatings shall be removed prior to acid pickling by suitable means.	Prior to hot-dip-galvanizing, for example

[a] Key to symbols used

Sa = blast-cleaning (ISO 8501-1);

St = hand-tool or power-tool cleaning (ISO 8501-1);

Be = acid pickling.

[b] A, B, C and D are initial conditions of uncoated steel surfaces (see ISO 8501-1).

[c] The representative photographic examples show only surfaces or surface areas that were previously uncoated and blast-cleaned with quartz sand. Blast-cleaning with quartz sand is forbidden in many countries. Due to their colour, the use of other blast-cleaning abrasives can lead to other appearances of the blast-cleaned surface, even after it is thoroughly cleaned.

[d] In the case of steel surfaces with painted or unpainted metal coatings, an analogous application of certain standard preparation grades can be agreed, provided that these are technically feasible under the given conditions.

[e] Mill scale is considered to be poorly adhering if it can be removed by lifting with a blunt putty knife.

[f] The factors influencing assessment shall be given particular consideration.

[g] This surface preparation grade can only be achieved and maintained under certain conditions which it might not be possible to produce on site.

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Annex B
(normative)

Standard preparation grades for secondary (partial) surface preparation

Table B.1 — Standard preparation grades for secondary (partial) surface preparation

Standard preparation grade[a]	Surface preparation method	Representative photographic examples in ISO 8501-1 or ISO 8501-2[b,c,d]	Essential features of prepared surfaces [For further details, including treatment prior to and after surface preparation (column 2), see ISO 8501-2:1994.]	Field of application
P Sa 2[e]	Localized blast-cleaning	B Sa 2 C Sa 2 D Sa 2 (apply to uncoated parts of the surface)	Firmly adhering paint coatings shall be intact[f]. From the surface of the other parts, loose paint coatings and most of the mill scale, rust and foreign matter are removed. Any residual contamination shall be firmly adhering.	The surface preparation of coated steel surfaces on which some paint coatings remain[g]
P Sa 2 1/2[c]		B Sa 2 1/2 C Sa 2 1/2 D Sa 2 1/2 (apply to uncoated parts of the surface)	Firmly adhering paint coatings shall be intact[f]. From the surface of the other parts, loose paint coatings and mill scale, rust and foreign matter are removed. Any remaining traces of contamination shall show only as slight stains in the form of spots or stripes.	
P Sa 3[e,h]		C Sa 3 D Sa 3 (apply to uncoated parts of the surface)	Firmly adhering paint coatings shall be intact[f]. From the surface of the other parts, loose paint coatings and mill scale, rust and foreign matter are removed. The surface shall have a uniform metallic colour.	
P Ma[e]	Localized machine abrading	P Ma	Firmly adhering paint coatings shall be intact[f]. From the surface of the other parts, loose paint coatings and mill scale, rust and foreign matter are removed. Any remaining traces of contamination shall show only as slight stains in the form of spots or stripes.	
P St 2[e]	Localized hand- and power-tool cleaning	C St 2 D St 2	Firmly adhering paint coatings shall be intact[f]. From the surface of the other parts, poorly adhering mill scale, rust, paint coatings and foreign matter are removed.	

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Table B.1 *(continued)*

Standard preparation grade[a]	Surface preparation method	Representative photographic examples in ISO 8501-1 or ISO 8501-2[b,c,d]	Essential features of prepared surfaces [For further details, including treatment prior to and after surface preparation (column 2), see ISO 8501-2:1994.]	Field of application
P St 3[e]	Localized hand- and power-tool cleaning	C St 3 D St 3	Firmly adhering paint coatings shall be intact[f]. From the surface of the other parts, poorly adhering mill scale, rust, paint coatings and foreign matter are removed. However, the surface shall be treated much more thoroughly than for P St 2 to give a metallic sheen arising from the metal substrate.	The surface preparation of coated steel surfaces on which some paint coatings remain[g].

[a] Key to symbols used:

P Sa = localized blast-cleaning of previously coated surfaces (ISO 8501-2);

P St = localized hand- and power-tool cleaning of previously coated surfaces (ISO 8501-2);

P Ma = localized machine abrading of previously coated surfaces (ISO 8501-2).

[b] In the case of steel surfaces with painted or unpainted metal coatings, an analogous application of certain standard preparation grades may be agreed, provided that these are technically feasible under the given conditions.

[c] There are no specific photographic examples for the P grades, because the appearance of the total surface thus prepared is significantly influenced by the type of existing coating and its condition. For surface areas without coating, the photographic examples given for the corresponding grades without the P apply. As a further clarification of the P grades, various photographic examples are given in ISO 8501-2 of such surfaces before and after treatment. In the case of grades P Sa 2, P St 2 and P St 3, for which no photographs are available, the appearance of the residual coatings will be analogous to that of grade P Sa 2 1/2 or P Ma.

[d] The factors influencing assessment shall be given particular consideration.

[e] P is used as the code-letter for the preparation grade in the case of previously coated surfaces with firmly adhering paint coatings which are to be allowed to remain. The principal characteristics of each of the two prepared surface areas, that with firmly adhering paint coating and that without any paint coating remaining, are specified separately in the relevant column. The P grades, hence, always refer to the total surface to be recoated and not only to the surface areas which are without paint coating after surface preparation. As to the treatment of remaining paint coatings, see ISO 8501-2:1994, 4.5.

[f] Paint coatings are considered as firmly adhering if they cannot be removed by lifting with a blunt putty knife.

[g] The following information should preferably be known about the existing coating:

— the type of paint coating (e.g. type of binder and pigment) or metal coating, together with its approximate thickness and date of application;

— the rust grade as defined in ISO 4628-3, with details of under-film corrosion, where applicable;

— the degree of blistering, as defined in ISO 4628-2;

— additional information regarding for instance adhesion (e.g. after testing as described in ISO 2409), cracking (ISO 4628-4), flaking (ISO 4628-5), chemical or other contaminants and any other important details.

Checking the compatibility of the planned coating with existing coatings or their residues is an integral part of the design of a protective paint system.

[h] This surface preparation grade can only be achieved and maintained under certain conditions which it may not be possible to produce on site.

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Annex C
(informative)

Procedures for removal of extraneous layers and foreign matter, native layers and contaminants

Table C.1 — Procedures for removal of extraneous layers and foreign matter

Matter to be removed	Procedure	Remarks[a]
Grease and oil	Water cleaning (6.2.1)	Fresh water with addition of detergents. Pressure (< 70 MPa) may be used. Rinse with fresh water
	Steam cleaning (6.2.2)	Rinse with fresh water
	Emulsion cleaning (6.2.3)	Rinse with fresh water
	Alkaline cleaning (6.2.4)	Aluminium, zinc and certain other types of metal coating may be susceptible to corrosion if strongly alkaline solutions are used
	Organic-solvent cleaning (6.2.5)	Many organic solvents are hazardous to health. If the cleaning is performed using rags, they shall be replaced at frequent intervals as otherwise oily and greasy contaminants will not be removed but will be left as a smeared film after the solvent has evaporated
Water-soluble contaminants, e.g. salt	Water cleaning (6.2.1)	Fresh water. Pressure (< 70 MPa) may be used
	Steam cleaning (6.2.2)	Rinse with fresh water
	Alkaline cleaning (6.2.4)	Aluminium, zinc and certain other types of metal coating may be susceptible to corrosion if strongly alkaline solutions are used. Rinse with fresh water
Paint coatings	Stripping (6.2.6)	Solvent-borne pastes for coatings sensitive to organic solvents. Residues to be removed by rinsing with solvents. Alkaline pastes for saponifiable coatings. Rinse thoroughly with fresh water. Stripping is restricted to small areas
	Dry abrasive blast-cleaning (6.3.3.1)	Shot or grit abrasives. Residuals of dust and loose deposits shall be removed by blowing off with dry oil-free compressed air or by vacuum cleaning
	Wet abrasive blast-cleaning (6.3.3.3)	Rinse with fresh water
	Water jetting (6.3.4)	For removal of poorly adhering paint coatings. Ultra-high-pressure (> 170 MPa) cleaning may be used for firmly adhering coatings
	Sweep blast-cleaning (6.3.3.4.1)	For roughening coatings or removal of the outermost coating layer
	Spot blast-cleaning (6.3.3.4.2)	For localized removal of coatings

[a] When rinsing and drying, structures with slots or rivets shall be treated with particular care.

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Table C.2 — Procedures for removal of native layers and contaminants

Matter to be removed	Procedure	Remarks[a]
Mill scale	Acid pickling (6.2.7)	The process is normally not performed on site. Rinse with fresh water
	Dry abrasive blast-cleaning (6.3.3.1)	Shot or grit abrasives. Residuals of dust and loose deposits shall be removed by blowing off with dry oil-free compressed air or by vacuum cleaning
	Wet abrasive blast-cleaning (6.3.3.3)	Rinse with fresh water
Rust	Same procedures as for mill scale, plus	—
	Power-tool cleaning (6.3.2)	Mechanical brushing may be used in areas with loose rust. Grinding may be used for firmly adhering rust. Residuals of dust and loose deposits shall be removed
	Water jetting (6.3.4)	For removal of loose rust. The surface profile of the steel is not affected
	Spot blast-cleaning (6.3.3.4.2)	For localized removal of rust
Zinc corrosion products	Sweep blast-cleaning (6.3.3.4.1)	Sweep blast-cleaning on zinc may be performed with any non-metallic blast cleaning abrasive
	Alkaline cleaning (6.2.4)	5 % (*m*/*m*) ammonia solution in combination with a synthetic-fabric pad with embedded abrasives may be used for localized spots of zinc corrosion. Alkaline cleaners may be used for larger surfaces. At high pH, zinc is susceptible to corrosion

[a] When rinsing and drying, structures with slots or rivets shall be treated with particular care.

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