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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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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 12944-4 was prepared by Technical Committee ISO/TC 35, *Paints and varnishes,* Subcommittee SC 14, *Protective paint systems for steel structures.*

ISO 12944 consists of the following parts, under the general title *Paints and varnishes — Protective paint systems for steel structures*:

— *Part 1: General introduction*

— *Part 2: Classification of environments*

— *Part 3: Design considerations*

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

— *Part 5: Protective paint systems*

— *Part 6: Laboratory performance test methods*

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

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

Annexes A and B form an integral part of this part of ISO 12944. Annexes C, D and E are for information only.

Introduction

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

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

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

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

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

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

This part of ISO 12944 describes different types of surface to be protected and gives information on surface preparation methods such as chemical, mechanical and flame 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.

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

Part 4:
Types of surface and surface preparation

1 Scope

This part of ISO 12944 deals with 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 part of ISO 12944 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 part of ISO 12944.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 12944. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 12944 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1461:—[1)], *Hot dip galvanized coatings on fabricated ferrous products — Specifications.*

ISO 2063:1991, *Metallic and other inorganic coatings — Thermal spraying — Zinc, aluminium and their alloys.*

ISO 2409:1992, *Paints and varnishes — Cross-cut test.*

1) To be published. (Revision of ISO 1459:1973 and ISO 1461:1973)

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

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

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

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

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

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

ISO 8501-1:1988, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and steel substrates after overall removal of previous coatings.*

Informative Supplement to ISO 8501-1:1988, *Representative photographic examples of the change of appearance imparted to steel when blast-cleaned with different abrasives.*

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/TR 8502-1:1991, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 1: Field test for soluble iron corrosion products.*

ISO 8502-2:1992, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 2: Laboratory determination of chloride on cleaned surfaces.*

ISO 8502-3:1992, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method).*

ISO 8502-4:1993, *Preparation of steel substrates before application of paints and related products — Tests for the assessment of surface cleanliness — Part 4: Guidance on the estimation of the probability of condensation prior to paint application.*

ISO 8503-1:1988, *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 8503-2:1988, *Preparation of steel substrates before application of paints and related products — Surface roughness characteristics of blast-cleaned steel substrates — Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel — Comparator procedure.*

ISO 8504-1:1992, *Preparation of steel substrates before application of paints and related products — Surface preparation methods — Part 1: General principles.*

ISO 8504-2:1992, *Preparation of steel substrates before application of paints and related products — Surface preparation methods — Part 2: Abrasive blast-cleaning.*

ISO 8504-3:1993, *Preparation of steel substrates before application of paints and related products — Surface preparation methods — Part 3: Hand- and power-tool cleaning.*

ISO 11124-1:1993, *Preparation of steel substrates before application of paints and related products — Specifications for metallic blast-cleaning abrasives — Part 1: General introduction and classification.*

ISO 11124-2:1993, *Preparation of steel substrates before application of paints and related products — Specifications for metallic blast-cleaning abrasives — Part 2: Chilled-iron grit.*

ISO 11124-3:1993, *Preparation of steel substrates before application of paints and related products — Specifications for metallic blast-cleaning abrasives — Part 3: High-carbon cast-steel shot and grit.*

ISO 11124-4:1993, *Preparation of steel substrates before application of paints and related products — Specifications for metallic blast-cleaning abrasives — Part 4: Low-carbon cast-steel shot.*

ISO 11126-1:1993, *Preparation of steel substrates before application of paints and related products — Specifications for non-metallic blast-cleaning abrasives — Part 1: General introduction and classification.*

ISO 11126-3:1993, *Preparation of steel substrates before application of paints and related products — Specifications for non-metallic blast-cleaning abrasives — Part 3: Copper refinery slag.*

ISO 11126-4:1993, *Preparation of steel substrates before application of paints and related products — Specifications for non-metallic blast-cleaning abrasives — Part 4: Coal furnace slag.*

ISO 11126-5:1993, *Preparation of steel substrates before application of paints and related products — Specifications for non-metallic blast-cleaning abrasives — Part 5: Nickel refinery slag.*

ISO 11126-6:1993, *Preparation of steel substrates before application of paints and related products — Specifications for non-metallic blast-cleaning abrasives — Part 6: Iron furnace slag.*

ISO 11126-7:1995, *Preparation of steel substrates before application of paints and related products — Specifications for non-metallic blast-cleaning abrasives — Part 7: Fused aluminium oxide.*

ISO 11126-8:1993, *Preparation of steel substrates before application of paints and related products — Specifications for non-metallic blast-cleaning abrasives — Part 8: Olivine sand.*

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

EN 10238:1996, *Automatically blast-cleaned and automatically prefabrication primed structural steel products.*

3 Definitions

For the purposes of this part of ISO 12944, the following definitions apply in addition to those given in ISO 12944-1.

3.1 abrasive blast-cleaning: The impingement of a high-kinetic-energy stream of blast-cleaning abrasive on to the surface to be prepared.

3.2 blast-cleaning abrasive: A solid material intended to be used for abrasive blast-cleaning. [ISO 11124-1; ISO 11126-1]

3.3 dust: Loose particulate matter present on a steel surface prepared for painting, arising from blast-cleaning or other surface preparation processes, or resulting from the action of the environment. [ISO 8502-3]

3.4 dew point: The temperature at which moisture in the air will condense out on to a solid surface. 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. [ISO 11124-1; ISO 11126-1]

3.7 mill scale: The 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. [ISO 11124-1; ISO 11126-1]

3.10 substrate: The surface to which the coating material has been applied or is to be applied. [EN 971-1]

3.11 surface preparation: Any method of preparing a surface for coating.

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

4 General

The primary objective of surface preparation is to ensure the removal of deleterious matter and to obtain a surface that permits satisfactory adhesion of the priming paint to the steel. 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 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. Since the cost of surface preparation is usually in proportion to the level of cleanliness, a preparation grade appropriate to the purpose and type of coating system or a coating system appropriate to the preparation grade which can be achieved should be chosen.

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. All relevant health and safety regulations shall be observed. 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 specified. These measures should normally be taken in connection with the manufacturing process before the surface preparation.

For further details, see ISO 8504-1.

5 Types of surface to be prepared

The surfaces to be prepared can be divided into the following:

5.1 Uncoated surfaces

Uncoated surfaces consist of bare steel, which may 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).

5.2 Metal-coated surfaces

5.2.1 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.

5.2.2 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.

5.2.3 Zinc-electroplated surfaces

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

5.2.4 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.

5.3 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 purposes of this part of ISO 12944, the expression “surfaces painted with prefabrication primer” has a restricted meaning, in accordance with EN 10238. It is restricted to automatic blast-cleaning and automatic priming.

5.4 Other painted surfaces

Other painted surfaces consist of steel/metal-coated steel that has already been painted .

6 Surface preparation methods

Oil, grease, salts, dirt and similar contaminants shall be removed as far as possible, 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 may 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.

6.1 Water, solvent and chemical cleaning

6.1.1 Water cleaning

This method consists in 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.

6.1.2 Steam cleaning

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

6.1.3 Emulsion cleaning

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

6.1.4 Alkaline cleaning

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

6.1.5 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.

6.1.6 Cleaning by means of chemical conversion

Cleaning by means of chemical conversion (e.g. phosphating, chromating) is used for hot-dip-galvanized surfaces, electroplated-zinc coatings and sherardized surfaces to give a suitable surface for painting. Otherwise alkaline solutions or inhibited acids may also be used to prepare the surface. Rinsing with clean, fresh water shall normally follow. This type of treatment shall only be used with the approval of the manufacturer of the paint system to be applied.

NOTE — Treatment by acid or alkaline solutions is known as “mordant wash”.

6.1.7 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.

6.1.8 Acid pickling

This process 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 Mechanical cleaning including blast-cleaning

6.2.1 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.

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

6.2.3 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.

6.2.3.1 Dry abrasive blast-cleaning

6.2.3.1.1 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.

6.2.3.1.2 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 may be injected into the air stream from a pressurized container or may 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.

6.2.3.1.3 Vacuum or suction-head abrasive blast-cleaning

This method is similar to compressed-air abrasive blast-cleaning (see 6.2.3.1.2) 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 may 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.

6.2.3.2 **Moisture-injection abrasive blast-cleaning** (compressed-air moisture-injection abrasive blast-cleaning)

This method is similar to compressed-air abrasive blast-cleaning (see 6.2.3.1.2) but with the addition, upstream of the nozzle, of a very small amount of liquid (usually clean, fresh water) 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.

6.2.3.3 Wet abrasive blast-cleaning

6.2.3.3.1 Compressed-air wet abrasive blast-cleaning

This method is similar to compressed-air abrasive blast-cleaning (see 6.2.3.1.2) 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.

6.2.3.3.2 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.

6.2.3.3.3 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 may be introduced either dry (with or without air) or as a wet slurry.

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

6.2.3.4 Particular applications of blast-cleaning

6.2.3.4.1 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 may 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 may be optimized. Normally, for sweep blast-cleaning low air pressure and fine grit is used.

6.2.3.4.2 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 may 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 2½.

6.2.4 Water blast-cleaning

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.

The following water blast-cleaning techniques are commonly used:

— high-pressure water blast-cleaning (70 MPa to 170 MPa);

— ultra-high-pressure water blast-cleaning (above 170 MPa).

NOTE — Pressures below 70 MPa are used for water cleaning (6.1.1).

6.3 Flame cleaning

An acetylene-oxygen flame is passed over the surface to be cleaned. Mill scale and rust are removed by the effect of the flame jet and the action of heat. After flame cleaning, the surface shall be treated by mechanically driven wire brushes and then cleaned to remove any remaining dust and contaminants prior to painting.

7 Surface preparation grades

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

Other preparation grades may 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.

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, Fl 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 may be required to dry. Where flash rusting occurs on a prepared surface, it may 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 2½, Sa 3 for blast-cleaning, St 2, St 3 for hand- and power-tool cleaning and Fl for flame cleaning.

The Informative Supplement to ISO 8501-1 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).

7.1 Uncoated surfaces

The final appearance of the prepared steel surface depends on the initial surface condition (for example 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.

In the case of cold-rolled sections and sheets (and similar components), the surfaces are in most cases very smooth and contaminated by impurities from manufacturing which are difficult to remove. In such cases roughening may be necessary and particularly intense cleaning, for example by blast-cleaning, is indispensable. Tarnish (not to be confused with mill-scale layers) need not be removed, unless otherwise agreed.

7.2 Metal-coated surfaces

If the metal coating (thermally sprayed, hot-dip-galvanized, zinc-electroplated or sherardized) has 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.

7.3 Surfaces painted with prefabrication primer

If a prefabrication primer has 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 standards listed in annex D.

7.4 Other painted surfaces

The surface to be prepared shall be assessed in accordance with ISO 4628-1 to 4628-6 (degree of blistering rusting, cracking, flaking and chalking). Assessment of under-film corrosion and adhesion (see ISO 2409) may also be considered.

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 has to be removed completely down to the steel, the grades defined in ISO 8501-1 are applicable.

If the paint has 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 2½, P Sa 3 for localized blast-cleaning, P St 2, 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 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 International Standard, 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

After the surface preparation procedure (cleaning as specified), the prepared surfaces shall be assessed as described in ISO 8501-1 or ISO 8501-2, i.e. the cleanliness is assessed by evaluating the appearance of the surface only. In many instances, this is sufficient for the purpose, but for coatings likely to be exposed to severe environments, such as water immersion and continuous-condensation conditions, consideration shall be given to testing for soluble salts and other invisible contaminants on the visually clean surface by the physical and chemical methods which form the subjects of the various 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

Before further coating, all contamination and all corrosion and weathering products that have been formed in the meantime shall be removed by suitable means, e.g. by water cleaning, wet abrasive blast-cleaning, steam cleaning, sweep blast-cleaning, cautious grinding or hand- or power-tool cleaning. Joints and damaged areas of priming coats shall be re-cleaned and repaired after assembly by an appropriate method selected from those described in clause 6.

If subsequent welding or riveting has taken place, all residues shall be removed in accordance with the specification. The most effective method is grinding followed by blast-cleaning. The method to be used shall be agreed between the interested parties.

It may 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. The surface of existing coatings (in particular zinc-rich coatings) shall not be burnished or smeared by extensive power-tool cleaning so that subsequent coatings cannot adhere properly.

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.

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 power of the zinc coating is restored. 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 6.2.3.4.1) 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;

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 may 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 use of hot water, pressurized water, steam cleaning, sweep blast-cleaning or hand- or power-tool cleaning may 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. Before application of further protective paint coatings, the surface shall be treated in accordance with clause 11.

For further information on thermally sprayed metal coatings, see ISO 2063.

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 power of the zinc coating is restored. 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 6.1.6) may be suitable.

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 power of the protective coating system is restored.

Contamination on 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 6.1.6) may be suitable. 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.

Annex A
(normative)

Standard preparation grades for primary (overall) surface preparation

Standard preparation grade[1]	Surface preparation method	Representative photographic examples in ISO 8501-1[2) 3) 4)]	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 (6.2.3)	B Sa 1 C Sa 1 D Sa 1	Poorly adhering mill scale, rust and paint coatings and foreign matter are removed.[5)]	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.[6)]
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 2½		A Sa 2½ B Sa 2½ C Sa 2½ D Sa 2½	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[7)]		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 (6.2.1, 6.2.2)	B St 2 C St 2 D St 2	Poorly adhering mill scale, rust, paint coatings and foreign matter are removed.[5)]	
St 3		B St 3 C St 3 D St 3	Poorly adhering mill scale, rust, paint coatings and foreign matter are removed.[5)] However, the surface shall be treated much more thoroughly than for St 2 to give a metallic sheen arising from the metal substrate.	
Fl	Flame cleaning (6.3)	A Fl B Fl C Fl D Fl	Mill scale, rust, paint coatings and foreign matter are removed. Any remaining residues shall show only as a discoloration of the surface (shades of different colours).	[6)]
Be	Acid pickling (6.1.8)		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.

1) Key to symbols used:
Sa = blast-cleaning (ISO 8501-1)
St = hand-tool or power-tool cleaning (ISO 8501-1)
Fl = flame cleaning (ISO 8501-1)
Be = acid pickling

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

3) The representative photographic examples show only surfaces or surface areas that were previously uncoated.

4) 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.

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

6) The factors influencing assessment shall be given particular consideration.

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

Annex B
(normative)

Standard preparation grades for secondary (partial) surface preparation

Standard preparation grade[1]	Surface preparation method	Representative photographic examples in ISO 8501-1 or ISO 8501-2[2) 4) 6)]	Essential features of prepared surfaces For further details, including treatment prior to and after surface preparation (column 2), see ISO 8501-2.	Field of application
P Sa 2[3)]	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.[5)] 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.[7)]
P Sa 2½[3)]		B Sa 2½ C Sa 2½ D Sa 2½ (apply to uncoated parts of the surface)	Firmly adhering paint coatings shall be intact.[5)] 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[3) 8)]		C Sa 3 D Sa 3 (apply to uncoated parts of the surface)	Firmly adhering paint coatings shall be intact.[5)] 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[3)]	Localized machine abrading	P Ma	Firmly adhering paint coatings shall be intact.[5)] 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[3)]	Localized hand- and power-tool cleaning	C St 2 D St 2	Firmly adhering paint coatings shall be intact.[5)] From the surface of the other parts, poorly adhering mill scale, rust, paint coatings and foreign matter are removed.	
P St 3[3)]		C St 3 D St 3	Firmly adhering paint coatings shall be intact.[5)] 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.	

For footnotes, see next page.

Footnotes to table

1) 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)

2) 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.

3) 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, subclause 4.5.

4) 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 2½ or P Ma.

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

6) The factors influencing assessment shall be given particular consideration.

7) The following information should preferably be known about the existing coating:

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

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

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

   d) 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.

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