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Introduction: Unprotected steel will corrode in contact with air (atmosphere) and water. Therefore, a number of techniques have been developed to protect steel parts from the effects of corrosion, and the irreversible damage that will result.
ISO (*International Organization for Standardization*) is a world-wide association with headquarters in Geneva, Switzerland. The ISO mission is to prepare standards for materials and processes. Test results and empirical data are recorded and made available to users, e.g. planners, design engineers, instructors, students, trades people and technicians. All persons concerned must make reference to applicable standards and procedures and they must become familiar with the basics of corrosion protection for steel structures and steel objects through the application of surface treatment and coating systems.
The DIN EN ISO 12944 standard for corrosion protection was introduced in 1998 as a European and International standard for the protection of steel surfaces, and this standard has become the basis for a number of directives and specifications.

Steel is a widely used and highly versatile material. It is an economic medium and is available world-wide, with a host of design possibilities. However, steel also has its disadvantages: when steel is in contact with oxygen and humidity, iron oxide will develop – or more commonly 'rust'. Aside from the poor appearance of unprotected steel structures, this oxidation jeopardises these structures as the steel components will deteriorate by up to 200 µm per year. Therefore, and right from the planning stage, special care should be exercised when welding, joining with other components in order to optimally design and position the various components. Extensive pre-treatment of the steel components and appropriate coating systems will prevent corrosion damage, and long useful service lives and high retention of the original value for many years are added rewards.

For the selection of the best suitable coating system, the following important issues should be clarified:

- **What is the physical location of the structure?** In a rural area, within a city, in an industrial environment, at the shoreline? Is the structure fully or partially under water or is it in contact with the ground?
- **What are normal / additional stress loads at/for the structure?** Industrial gases, high humidity, rain, salt, mechanical stress loads, long-term presence of condensed water, etc.
- **What is the planned service life for the structure?** 5, 10, 15 or 25 years?
- **What will the appearance of the planned building be?** Will the visual impression be secondary or will there be special colour effects?
- **Will the project include regular cleaning and maintenance work?** Will road salt on bridges and railings be cleared off at the end of the winter season?

Scope of application:

Type of structure:	Structures made from alloyed or low-alloyed steel, wall thickness 3 mm and more, designed in compliance with a safety certification.
Type of surfaces to be coated and surface treatment:	Uncoated steel surfaces, hot sprayed zinc coating, hot-dip zinc coating and galvanized zinc coating, other surface coatings.
Environmental conditions:	Six corrosivity categories (C1 – C5 I/M) for atmospheric conditions. Three categories for structures in water or soil.

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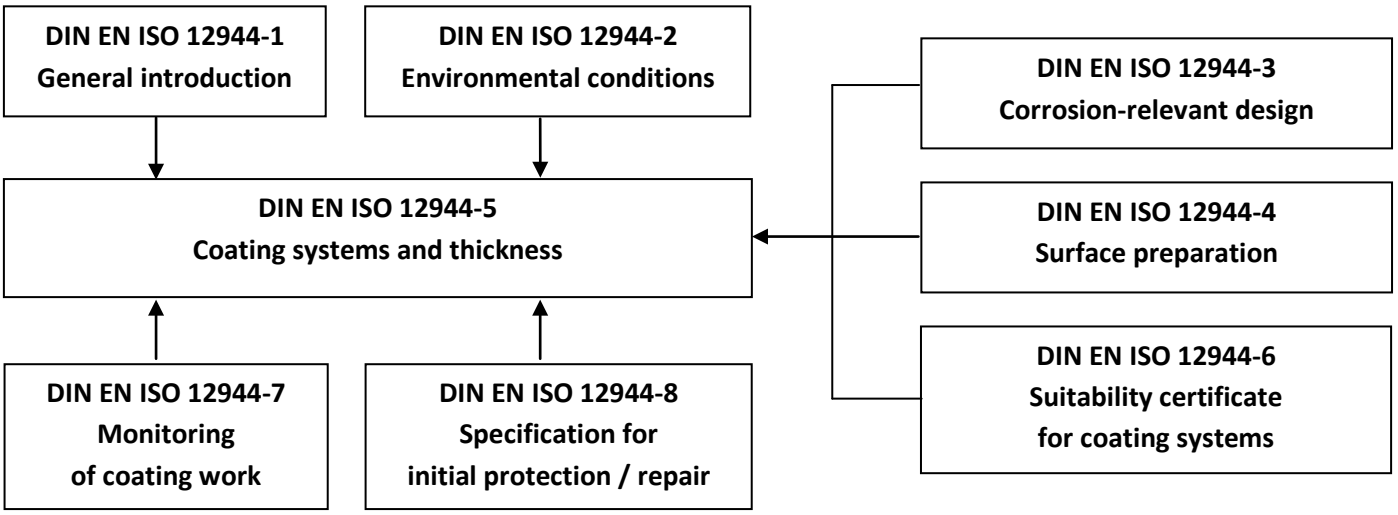
General Information: ISO 12944 Information TI – G – 09 / UK

Type of coating system:	Coating materials which dry/cure/harden in the surrounding atmosphere. What is the desired coat thickness and which materials?
Type of measure:	Initial protection and/or repair
Service life of coating:	Three time periods for expected endurance.

DIN EN ISO 12944 comprises eight parts as follows:



Anticipated duration of protection endurance for coating systems according to DIN EN ISO 12944-1 and -5

Duration of protection	
Time frame	Years
Short L (Low)	2 – 5
Medium M	5 - 15
High H	more than 15

The indicated duration of the protection until the first repair work depends on the corrosion stress or environmental conditions, and on the selected type of coating.
The first partial repair phase for reasons of corrosion is due when the coating system shows rust grade Ri 3 in accordance with ISO 4628-3, unless contractual provisions dictate specific time periods. The duration of protection does not constitute a warranty period. It is a technical recommendation to assist the ordering party when defining periodic service and maintenance.

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Classification of environmental conditions according to DIN EN ISO 12944-2

Climate category	Application area		Recommended total coating thickness
	outdoors	indoors	
C1 negligible		Heated rooms, e.g. offices, shops, schools, hotels	80µm
C2 low	Low pollution, mostly rural areas	Unheated buildings where condensation may occur, e.g. storage facilities, sports centres	120-160µm
C3 medium	Urban and industrial areas, moderate pollution, coastal regions with low salt concentration	High humidity rooms with some air pollution, e.g. breweries, dairies, food production facilities	160-200µm
C4 severe	Industrial areas, coastal regions with moderate salt concentration	Chemical plants, swimming pools, boat houses above sea water	200-240µm
C5 – I extreme (industrial)	Industrial areas with high humidity and aggressive atmospheres	Buildings and areas with ever present condensation and heavy pollution	240-320µm
C5 - M extreme (maritime)	Coastal and offshore regions with high salt concentration	Buildings and areas with ever present condensation and heavy pollution	240-320µm

This information does not consider stress categories in water and soil.
Im1 = Fresh water – Im2 = Salt water or brackish water – Im3 = Soil
(Steel decomposition – unprotected 250-1000µm/year)

Pre-treatment of surface:

Proper pre-treatment of surfaces is a prerequisite for a durable coating system. The best coating system will fail if applied to poorly cleaned and insufficiently treated surfaces.
For steel surfaces, we recommend blasting with a suitable blasting medium (minimum SA 2.5) for a roughness of 25 – 50µm. The primer coat should measure 80 – 160µm. At higher roughness grades the primer coat should be increased 3-fold. For further information please refer to the technical information provided with the product or contact us via our service hotline.

Steel surfaces always show ‘ferrous‘ deposits, such as rust, rolling skin and mill scale, and ‘non-ferrous‘ deposits such as oils, grease, salts, dust, condensation, etc., any of which reduce the desired bonding of a coating system and support corrosion.
These deposits and impurities must be totally removed (refer to the table below).

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Hot-dip galvanised steel surfaces do not show rolling skin and mill scale, however, zinc corrosion products, zinc salts and remains of flux must be removed. Users must always be aware that there is an oily layer on freshly zinc-coated surfaces.

Surface pollutions and removal/cleaning methods according to DIN EN ISO 12944-4:

Pollution	Cleaning processes	Remarks
Water-soluble pollution, salts, mineral matters	Cleaning with water or steam jet	Clean water with or without cleaning agents, afterwards rinsing with clean water
Oils, greases	Cleaning with alkaline solutions Cleaning with solvents	Possible aggressive action at metallic coatings, therefore rinsing with clean water. Cleaning and dry rubbing, using several pieces of cloth.
Rolling skin and mill scale	Pickling with acidic solution Dry blasting Wet blasting Flame blasting	Always followed by rinsing with clean water. Use suitable blasting medium, remove any dust. Always followed by rinsing with clean water. Remove any residue.
Rust	Process as with rolling skin and mill scale Mechanical tools Selective/spot blasting High-pressure water jet	 Mechanical brushing or grinding Local removal of rust Removal of loose rust
Existing coatings	Pickling Dry blasting High pressure water jet Mechanical tools Sweep blasting	Alkaline or solvent-containing products, afterwards rinsing with ample clean water Use suitable blasting medium, remove any dust. Pressure 100 - 250 bar, depending on coating. Grinding – roughening of bonded coating or removal of coating. Roughening of coating, remove any dust.
Zinc corrosion products	Sweep blasting Alkaline cleaning	(Smooth blasting) for zinc use corundum, silicates must not destroy zinc coating. Use alkaline cleaning agents, rinse with clean water.

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Corrosion through coating systems:

Coating materials are applied in liquid form onto the steel surface/galvanized steel surface where they create a homogeneous, coherent lacquer coat. This is a film-forming process which is decisive for the overall quality of the protective coating.
Film-forming can be the result of either physical drying or chemical drying/curing/hardening. This depends on the type of binding agent / resin. Chemical curing/hardening is effected through a second component, and in most cases, this medium is added in a precise proportion to the base material. The coating is dried in the surrounding atmosphere, at 20°C or by furnace drying in closed cabins at up to 80°C or by means of irradiation.
Powder lacquers or baking enamels are normally baked at 80°C to 250°C. Not every paint shop or lacquering service has the facilities for powder lacquers and the necessary processes.

Classic lacquer structure:

1. Zinc dust epoxy primer is mostly used as the adhesion or basic layer, serving as a sound ‘foundation‘ on the blasted steel surfaces. Other corrosion protecting pigments are zinc phosphate and zinc oxide.

2. An intermediate coating layer increases the anti-corrosion properties, it smoothes possible unevenness, supports a uniform distribution and enhances the gloss of the top coat. If required, this intermediate layer – mostly made from epoxy-based primer (EP) – can be ground to create a smoother surface.

3. The top coat essentially produces the optical effects, such as colour hue and surface texture, i.e. high gloss, matt, structured, lacquer effects, etc. By the same token, they must be abrasion resistant, of satisfactory UV resistance and they must prevent the effect of aggressive elements in the atmosphere.

The term ‘Duplex Systems’ hot-dip galvanising + coating:

A coating system is applied onto the hot-dip galvanised steel surface. This provides for substantially longer protection (extension factor 1.5 to 2.5 x) than the sum of the protection times of zinc plating and coating systems.

Laboratory tests for the assessment of coating systems:

DIN EN ISO 12944-6 describes laboratory tests for assessment purposes. Using a salt spraying device, ageing of the object is accelerated owing to the increased corrosion stress. These tests serve as reference data for a safe forecast regarding the corrosion protection properties of a given surface coating system.

Execution and monitoring of coating work (DIN EN ISO 12944-7):

The following conditions must be met before a steel object will enjoy a long-lasting corrosion protection:

- Surface preparation in compliance with approved standards
- Preparation and coating executed by professionals of the trade
- Certified coating media suitable for the specific demands, proper storage and use of the coating media
- Coating application of the desired minimum dry coat thickness

The contracted party can best achieve these conditions by prior development of a quality management scheme certified to DIN EN ISO 9000 which defines and monitors the various processing and application phases.
The contracted party must perform all work details and ensure its own continuous quality monitoring. If so required, the producer of the coating media should be contacted for competent professional consulting on specific jobs.

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Preparing of specifications for initial protection systems and for regular maintenance:

The last part of **DIN EN ISO 12944-8** contains procedures for the preparation of specifications for initial protection and maintenance, details for coating system specifications, and form sheets for final reports and test reports.
For the initial corrosion protection of a structure, users should select a coating system that ensures long-lasting protection.
Planning for maintenance and for applicable repairs is facilitated when users can refer to professionally prepared documentation or to records of previous maintenance or repair work.
Before preparing a specification, the user should identify the situation and status as regards the need for a complete renewal or for spot or isolated corrective measures on the coating system.
An exact description of the performance expected of the desired coating system on steel surfaces should be the basis for any contractual agreement between the ordering party and the executing contractor. The specification must describe the object in full detail and define the extent of the work details and of the coating media to be used. The contractual agreement must also include the issues of monitoring and control, quality control and planned warranty periods.

(Source: Bundesverband Korrosionsschutz e.V. und Verband der deutschen Lack- und Druckfarbenindustrie e.V.) [Federal Association for Corrosion Protection and Association of German Paint, Lacquer and Printing Ink Industries]