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General Information: ISO 12944 TI – G 9 / USA

Introduction: Unprotected steel will corrode in contact with air (atmosphere), in water or earth. Therefore, a number of techniques have been developed to protect steel parts from the effects of corrosion, thereby precluding long-term damage.
ISO (*International Organisation for Standardisation*) is a world-wide association with headquarters in Geneva, Switzerland. The ISO mission is to prepare standards for materials, directives and processes. Test results and empiric data are recorded and made available to users, viz. planners, designing engineers, instructors, students, trades and technicians. All persons concerned shall take reference to applicable standards and procedures and they shall become familiar with the basics of corrosion protection for steel structures and steel objects through the application of surface treatment and coating systems.
The standard for corrosion protection DIN EN ISO 12944 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 widely used and highly versatile material. It is priceworthy and available world-wide with a host of design possibilities. However, steel also has its handicap: 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 addressed when welding, joining with other components 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 condensated water, etc.
- **What is the planned service life for the structure?** 5, 10, 15 or 25 years?
- **What shall be the designed appearance of the building?** Shall the visual impression be secondary or shall there be special colour effects?
- **Will the project include regular cleaning and maintenance work?** Will road salt on bridges and railing 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 galvanised zinc coating, other surface coatings.

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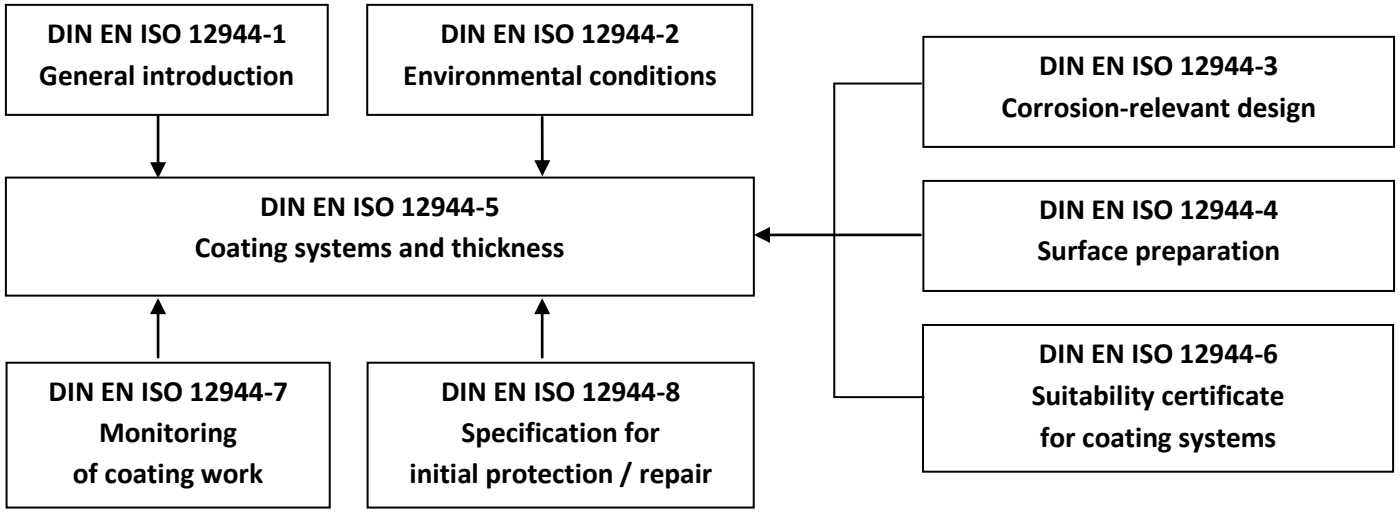
Environmental conditions:	Six corrosivity categories (C1 – C5 I/M) for atmospheric conditions. Three categories for structures in water or ground.
Type of coating system:	Coating materials which dry/cure/harden in the surrounding atmosphere. What is the desired coat thickness and which materials?
Type of measure:	Initial protection and/or repair
Service life of coating:	Three time periods for the expected endurance.

DIN EN ISO 12944 comprises eight parts which include the following parts:



Anticipated duration of protection endurance for coating systems acc. 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, respectively, 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 acc. to ISO 4628-3, unless contractual provision 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 acc. 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 pool, 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 prerequisite for a durable coating system. The best coating system will fail when it was 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 a oily layer on freshly zinc coated surfaces.

Surface pollutions and removal/cleaning methods acc. 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 cloths.
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 – roughing of bonded coating or removal of coating. Roughing 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/galvanised steel surface where they create a homogenous, 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 IR radiation.
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.

Classical laquer 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, effect lacquers, etc. By the same token, they shall be abrasion resistant, of satisfying UV resistance and they shall prevent the effect from aggressive media 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 system.

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.

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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 enduring 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 for 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 define and monitor the various processing and application phases.
The contracted party shall perform all work details and ensure continuous own quality monitoring. If so required, the producer of the coating media should be contacted for competent professional consulting on specific jobs.

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

The last part of **DIN EN ISO 12944-8** holds: Procedures for the preparation of specifications for initial protection and maintenance, details for coating system specifications, form sheets for final reports and test reports.
For the initial corrosion protection of a structure, users should select a coating system ensuring long protection endurance.
Planning for maintenance and for applicable repair is facilitated when users can refer to a professionally prepared documentation or to records of previous maintenance or repair work.
Before preparing a specification, user should identify the situation and status as to the need for a complete renewal or for spot or isolated corrective measures at the coating system.
An exact description of the expected performance for 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 shall 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 shall also include the issues of monitoring and control, quality control and planned warranty times.

(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]