



## TECHNICAL STANDARDS ORLEN S.A. TECHNOLOGY OFFICE

## TECHNICAL STANDARDS ORLEN S.A. TECHNOLOGY OFFICE FOR ANTICORROSION WORKS

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## INFORMATION SHEET

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## 1 Subject

The subject of the standard are the requirements for the design, construction and inspection of anticorrosion protection performed on equipment and elements of technical infrastructure according to the scope in 1.1.

### 1.1 Scope of standard

This standard is a set of minimal technical requirements for newly planned investment, modernization and maintenance works. The standard is used for:

- steel structures
- piping, valves and fittings
- equipment (e.g. apparatus, storage tanks, pressure tanks, pumps, etc.).

Standard for anticorrosion works does not apply for:

- concrete surfaces
- HVAC systems
- cable trays, electric equipments
- thermo-indicating paints
- equipment not related to production process (e.g. in office spaces on the installation site buildings).

#### Clarifications:

a. Surfaces to be coated:

- All insulated and uninsulated carbon steel and low alloy steel surfaces
- Insulated stainless steel surfaces operating in the temperature range from 50°C to 175°C in areas at risk of increased humidity containing chlorides, e.g. in the area of water blocks, port quays, etc.

b. Surfaces not to be coated:

- Other insulated stainless steel surfaces.
- Other non-ferrous metal surfaces (aluminium, copper alloys, etc.), unless required for reasons of appearance or safety identification
- Uninsulated stainless steel surfaces, unless required for reasons of appearance or safety identification
- Nickel Alloy surfaces
- Galvanized steel gratings
- Machined surfaces as flange faces, screw threads.

### 1.2 Terms and definitions

**Durability** – expected life of a protective coating system to the first major maintenance painting.

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**Coat** – continuous layer of metal material or a continuous film of paint, resulting from a single application.

**Finish** – protective coating on the external layer of the vessel.

**Paint** – pigmented coating material which, when applied to a substrate, forms an opaque dried film having protective, decorative or specific technical properties.

**Protective coating system** - sum total of the coats of metal materials and/or paints or related products which are to be applied or which have been applied to a substrate to provide corrosion protection.

**Protective paint system** - sum total of the *coats of paints* or related products which are to be applied or which have been applied to a *substrate* to provide *corrosion* protection.

**Substrate** – surface to which the coating material is applied or is to be applied.

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

**Corrosion exposure** - environmental condition that leads to corrosion.

**Atmosphere** - a mixture of gases, aerosols and particles surrounding the object.

**Atmospheric corrosion** - corrosion occurring at ambient temperature, in the atmosphere as a corrosive environment.

**Industrial atmosphere** - an atmosphere with corrosive contamination.

**Surface preparation** - any method of surface preparation before applying finish, coating or painting systems.

**Abrasive blast-cleaning** - impingement of a high-kinetic-energy stream of an abrasive on the surface to be prepared.

**Dew point** - temperature at which moisture contained in the air will condense on a surface.

**Mill scale** - a thick layer of oxides formed on steel during hot processing or cold processing.

**White rust** - corrosion products with a white to dark gray color on the galvanized surface.

**Coating thickness (DFT)** - thickness of the coating after curing the layer applied to the substrate (dry film thickness).

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**Nominal coating thickness (NDFT)** - thickness determined for a given coating or a complete painting system, ensuring the required durability (nominal dry film thickness).

**Layer** - continuous, fresh painting, created from the paint product as a result of a single application.

**Primer for temporary protection (shop primer)** - fast drying paint applied to a blast cleaned construction to protect the steel during assembly, while maintaining the ability to weld steel.

**Life cycle of a paint product** - the time at which a paint product having a good properties if stored in original, sealed packages under normal storage conditions.

**Adhesion** - all forces binding the coating to the surface.

**Hot dip galvanizing** - making zinc or iron alloy coatings with zinc on steel and cast iron products by dipping properly prepared steel or cast iron in liquid zinc.

**Construction journal** - a document of the scope of work as well as tasks and circumstances occurring during their implementation, which are important in assessing the correctness of their implementation. For works carried out accordance with the Construction Law, this is an official document.

**Supervision inspector** - the contracting authority, represents the interests of the contractor on the construction site by controlling the compliance of the works with the project documentation, technical specification, regulations, technical knowledge rules and the provisions of the contract terms.

### 1.3 Normative references

#### **PN-EN ISO 8501-1:2008**


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

#### **PN-EN ISO 8501-2:2011**

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

#### **PN-EN ISO 8501-3:2008**

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

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#### **PN-EN ISO 8501-4:2021-04**

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

#### **PN-EN ISO 8502-3:2017-03**

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)

#### **PN-EN ISO 8502-4:2017-03**

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

#### **PN-EN ISO 8502-6:2020-11**

Preparation of steel substrates before application of paints and related products  
- Tests for the assessment of surface cleanliness - Part 6: Extraction of soluble contaminants for analysis - The Bresle Method

#### **PN-EN ISO 8502-9:2021-03**

Preparation of steel substrates before application of paints and related products  
- Tests for the assessment of surface cleanliness - Part 9: Field method for the conductometric determination of water-soluble salts

#### **PN-EN ISO 8503-1:2012**

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

#### **PN-EN ISO 8503-2:2012**

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

#### **PN-EN ISO 8503-3:2012**

Preparation of steel substrates before application of paints and related products  
- Surface roughness characteristics of blast-cleaned steel substrates - Part 3: Method for the calibration of ISO surface profile comparators and for the determination of surface profile - Focusing microscope procedure



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#### **PN-EN ISO 8503-4:2012**

Preparation of steel substrates before application of paints and related products  
- Surface roughness characteristics of blast-cleaned steel substrates - Part 4:  
Method for the calibration of ISO surface profile comparators and for the  
determination of surface profile - Stylus instrument procedure

#### **PN-EN ISO 8503-5:2017-04**

Preparation of steel substrates before application of paints and related products  
- Surface roughness characteristics of blast-cleaned steel substrates - Part 5:  
Replica tape method for the determination of the surface profile

#### **PN-EN ISO 8504-1:2020-04**

Preparation of steel substrates before application of paints and related products  
- Surface preparation methods - Part 1: General principles

#### **PN-EN ISO 8504-2:2020-04**

Preparation of steel substrates before application of paints and related products  
- Surface preparation methods - Part 2: Abrasive blast cleaning

#### **PN-EN ISO 8504-3:2019-01**

Preparation of steel substrates before application of paints and related products  
- Surface preparation methods - Part 3: Hand- and power-tool cleaning

#### **PN-EN ISO 12944-1:2018-01**

Paints and varnishes - corrosion protection of steel structures by protective  
paint systems - Part 1: General introduction

#### **PN-EN ISO 12944-2:2018-02**

Paints and varnishes - Corrosion protection of steel structures by protective  
paint systems - Part 2: Classification of environments

#### **PN-EN ISO 12944-3:2018-02**

Paints and varnishes - Corrosion protection of steel structures by protective  
paint systems - Part 3: Design considerations

#### **PN-EN ISO 12944-4:2018-02**

Paints and varnishes - Corrosion protection of steel structures by protective  
paint systems - Part 4: Types of surface and surface preparation

#### **PN-EN ISO 12944-5:2020-03**

Paints and varnishes - Corrosion protection of steel structures by protective  
paint systems - Part 5: Protective paint systems

#### **PN-EN ISO 12944-6:2018-03**

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



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#### **PN-EN ISO 12944-7:2018-01**

Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 7: Execution and supervision of paint work

#### **PN-EN ISO 12944-8:2018-01**

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

#### **PN-EN ISO 2808:2020-01**

Paints and varnishes - Determination of film thickness

#### **PN-ISO 19840:2009**

Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Measurement of, and acceptance criteria for, the thickness of dry films on rough surfaces

#### **PN-EN ISO 4624:2016-05**

Paints and varnishes - Pull-off test for adhesion

#### **PN-EN ISO 2409:2021-03**

Paints and varnishes - Cross-cut test

#### **PN-EN ISO 4628-1:2016-03**

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

#### **PN-EN ISO 4628-2:2016-03**

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

#### **PN-EN ISO 4628-3:2016-03**

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

#### **PN-EN ISO 4628-4:2016-03**

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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### **PN-EN ISO 4628-5:2016-03**

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

### **PN-EN ISO 4628-6:2012**

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

### **ASTM D4752 – 10 (2015)**

Practice for measuring mek resistance of ethyl silicate (inorganic) zinc-rich primers by solvent rub

### **PN-EN ISO 14713-1:2017-08**

Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 1: General principles of design and corrosion resistance

### **PN-EN ISO 1461:2011**

Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods

### **PN-EN ISO 11126-3:2018-10**

Preparation of steel substrates before application of paints and similar products - Technical requirements for non-metallic abrasives for abrasive blasting - Part 3: Copper slag

### **PN-EN ISO 11124-3:2018-11**

Preparation of steel substrates before application of paints and similar products - Technical requirements for metal abrasives used in abrasive blasting - Part 3: Spherical and sharp-angle shot from high-carbon cast steel

### **PN-EN ISO 11127-6:2012**

Preparation of steel substrates before application of paints and related products - Test methods for non-metallic blast-cleaning abrasives - Part 6: Determination of water-soluble contaminants by conductivity measurement

### **PN-EN ISO 11127-7:2012**

Preparation of steel substrates before application of paints and related products - Test methods for non-metallic blast-cleaning abrasives - Part 7: Determination of water-soluble chlorides

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#### **PN-EN 14879-1:2006**

Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media - Part 1: Terminology, design and preparation of substrate

#### **PN-EN 14879-2:2008**

Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media - Part 2: Coatings on metallic components

#### **PN-EN 14879-4:2009**

Organic coating systems and linings for protection of industrial apparatus and plants against corrosion caused by aggressive media - Part 4: Linings on metallic components

#### **Journal of Laws no 16 item 156**

Regulation of the minister of economy, labor and social policy of January 14, 2004 on occupational health and safety for surface cleaning, spray painting and thermal spraying.

#### **PN-EN 61340-2-3:2016-11**

Electrostatics – Part 2-3: Methods of test for determining the resistance and resistivity of solid materials used to avoid electrostatic charge accumulation

#### **PN-EN ISO 29601:2011**

Paints and varnishes — Corrosion protection by protective paint systems — Assessment of porosity in a dry film

## **2 General requirements for anti-corrosion protection**

### **2.1 Selection of coating protection system**


Coating system shall be properly selected to prefabrication, assembly and operation conditions of protected structure.

Informations about particular painting systems used in Orlen S.A. are given in point 5, Table 5 and Table 6.

### **2.2 Planning**

All details concern execution of anticorrosion works, such as place, technology, quantity, equipment, time period, schedule, inspection notification procedure or additional inspection requirements, selected places and quantity of reference areas, shall be establish prior to start of works.

All steel surfaces shall be blast cleaned and coated by at least one layer on prefabrication prior to assembly on site.

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### 2.3 Equipment protection and clean up

Before start anticorrosion works on site, in agreement with the user, make necessary covers against mechanical damages, contamination or painting electrical and automatical equipment, connections or other areas without surface protection (steel connectors or other external tanks equipment). After finish the work all masking, abrasive material and other garbage shall be removed.

### 2.4 Ambient conditions

Final blast cleaning and painting shall be not be executed in relative humidity higher than 85%. As required, optimal air temperature shall be higher than 5°C, surface temperature shall be higher min 3°C than dew point. Minimum and maximum application and curing temperature coats is developed by product manufacturer and have to be placed in technical data sheets material.

### 2.5 Coating material

Coating material shall be selected because of:

- Protection properties,
- Assembly and maintenance conditions,
- Technical requirements of usage,
- Experience with the material,
- Material availability,
- Requirements to health, safety and environment,
- Economical aspect.

Coating material shall be stored in original container according to information in technical data sheets. Each product shall be identified, have serial number and production date.

### 2.6 Steel material

For new projects maximum rust grade shall be B acc. ISO 8501.

Shop-primers shall be removed before application proper coating system.

### 2.7 Protection design against corrosion of steel structures

The basic design principles related protection against corrosion are included in PN-EN ISO 12944-3. The most important of them are:

- designing shapes without fences, bends and recesses to retain water and dirt,
- application of elements with smooth surfaces and stiffening sections from the inside,
- tanks, large box constructions must have an appropriate number of manholes

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with the dimensions enabling the operator to enter with a suitable equipment for cleaning the surface or painting, connecting the necessary ventilation to maintain the required atmosphere parameters inside,

- small size spaces, completely closed, should be tight, edges closed with a continuous weld,
- all contact joints should be continuous, i.e. continuous welds around the entire circumference of the adhesion (without overlap welding), double-sided butt welds, full penetration marginal welded joints,
- the structure must be designed in a way to ensure that works related to corrosion protection are carried out at all construction stages, also during maintenance and renovation works,
- any kinds of gaps should be avoided, the boundary relationships between the length and width of the gap are given in the norms.

## 2.8 Classification of environmental aggressiveness

The atmospheric environments sections, according to PN-EN ISO 12944-2 standard, are based on the corrosion rate in one year of carbon steel and zinc. In addition to climatic factors, the corrosive aggressiveness of the atmosphere is shaped by environmental factors. A significant influence on corrosion in industrial atmosphere characteristic for the petroleum industry are: SO<sub>2</sub>, H<sub>2</sub>S, NO<sub>x</sub>, CO<sub>2</sub>, hydrocarbon vapors. By adopting the following criteria, the standard distinguishes between five categories of atmospheric corrosivity labeled as C1 to CX, with very high corrosivity in industrial atmospheres marked as "C5". For the aquatic environment and soil, the corrosivity categories are marked as Im1 to Im4.

The ORLEN S.A. production plant installations in Płock and PTA Plant in Włocławek should be assumed as corrosivity category C5 very high (industrial) according to PN-EN ISO 12944-2 - "industrial areas with high humidity, aggressive atmosphere and coastal areas with high salinity". Corrosion can be locally intensified by impurities from the installation (eg: acids, alkalis, salts, aggressive gases) and then, depending on the specificity of the installation, the designer should increase the corrosiveness depending on the local exposure. In case of fully build-in industrial halls, it is allowed to use corrosivity categories C4-high.

For the soil environment we assume the category of corrosivity Im3 (underground tanks, piles and steel piping). Depending on the agreed design solutions, cathodic protection together with suitable coatings may be used.

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## 2.9 Durability

The durability of the protective paint/ coating system after the first major renovation must be agreed between concerned sides. During planning and design phase the possibility of renovation or repair should be take into consideration. The durability of coatings in the PN-EN ISO 12944-1 standard is expressed in relation to 4 durability ranges:

- Low (L) to 7 years,
- Medium (M) 7 years to 15 years,
- High (H) 15 years to 25 years,
- Very High (VH) over 25 years.

The preferred durability period should be taken as a high (H), from 15 years to 25 years according to PN-EN ISO 12944-1. In cases where, after assembly, corroded structural elements have limited access or are unavailable, to ensure the durability of the structure during use, the use of very high durability (VH) over 25 years should be considered. In the case of fire protection VH durability (over 25 years) permitted a coating based on an epoxy binder.

## 2.10 Fire protection

Fire protection based on cement and epoxy binder may be used. Selected material should consider facility operating conditions. Fire protection system requires valid European technical approval or national technical assessment/ technical approval of Building Research Institute and must have positive opinion of the Orlen S.A.Company Fire Brigade.

## 2.11 Water piping for fire protection systems

Water piping for fire protection systems are protected by coating internal and external surfaces by hot dip / galvanizing method according to PN-EN ISO 1461. According to health and safety requirements, they are subject to painting in order to give them a distinctive color. Fire protection piping should be red (RAL 3001) in accordance with Table 1.

## 2.12 Piping and underground constructions.

Coatings used for comprehensive protection, i.e. including cathodic protection (e.g. underground constructions), must be resistant to factors associated with cathodic protection. Such declaration must be submitted by the producer.

## 2.13 Technological and storage tanks

Coatings for internal tank surfaces are selected individually by the designer, depending on the medium type. It is recommended to base on lists of chemical resistance provided by producers and use at least two layers of coating.

For corrosion protection coatings of fuel tanks internal surfaces, a special



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requirement is to determine the resistance of Ru discharge, which for maximum coating thickness cannot be higher than  $1 \cdot 10^6$  Q, in accordance with the requirements of PN-EN 61340-2-3:2016-11.

For external surfaces of on-ground tanks for fuels, it is required that the coating used reflects at least 70% of solar reflectance.

Confirmation of compliance with the above requirements must be included in technical data sheets of the product or a confirmed declaration submitted by the manufacturer.

The Contractor providing corrosion protection of technological and storage tanks is required to ensure a warranty on the internal coating for a period not shorter than until the first/ subsequent revision of the tank, both for new facilities and renovation work. Detailed terms of the warranty should be established during purchase stage.

## 2.14 Tube bundle of the water cooled heat exchangers

Water circuit surfaces of the heat exchangers components, such as: distribution chambers, floating heads, tube bundle (tube sheets and tube inner surfaces) are subject to anti-corrosion protection in accordance with presented Standard requirements. The tube inner surfaces paint coating application should be done using a specialized spraying or overflow methods. The Contractor should present years of professional experience in the field of the above mentioned methods, confirmed by references. The coating and coating thickness should be selected by the Contractor depending on the operating conditions of the equipment and presented in the technical offer. The coating should be porosity tested using the low-voltage method in accordance with PN-EN ISO 29601, and in the case of porosity detection, repairs should be performed in accordance with coating material technical data sheet. The quality documentation should include photos of vanishing works. Supervision over the process by the Contractor side should be provided by a coating inspector certified by e.g.: NACE, FROSIO, etc.

## 2.15 Piping in pipe culverts

Sections of piping running in culverts, due to limited access, should be protected against corrosion. The method of protection is chosen by the designer, depends on the piping operating temperature and must ensure a very high durability (over 25 years). The protections used are polyolefin insulations and fillings in the space between the pipe and the casing pipe.



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## 2.16 Steel constructions and equipment colors

All uninsulated piping should have colors and markings in accordance with the colors given in Table 1. The surface layer of piping should be painted entirely with the color corresponding to the particular factor (the exception is hydrocarbon expansion medium – see notes in Table 1). Marking in the form of bands is allowed. The direction of medium flow in the pipes is marked with an arrow. The color of the text should be contrasting with the background (black for the yellow background, orange, gray and white for the brown, blue and violet background). Coloring of technical equipment and constructions in accordance with the colors given in Table 2.

**Table 1. Piping marking colors**

No.	Medium	Color	RAL	Notes
1	Water	Green	6010	*hydrocarbons for which the vapor pressure increases when temperature increases, use labels only in the form of bands
2	Steam	Aluminum	9006	
3	Air	Blue	5012	
4	Flammable gases	Yellow	1023	
5	Non-flammable gases	White	9016	
6	Acids	Orange	2004	
7	Alkali	Violet	4005	
8	Liquids and combustible oils	Brown*	8003	
9	Non-flammable liquids	Beige	1002	
10	Bitumen and heavy oils	Black	9017	
11	Fire protection piping	Red	3001	

**Table 2. Technical equipment and construction marking colors**

No.	Element	Color	RAL	Notes
1	Uninsulated equipments and columns	Gray light	7035	**min. 70% solar reflectance
2	Ground storage tanks	White**	9016	
3	Flyovers, shelves	Gray light	7035	
4	Stairs, ladders, railings	Yellow	1023	
5	Steel chimneys	Silvery	9006	
6	Reinforced concrete chimneys	Gray light	7035	
7	Fire protection steel structure	Blue light	5012	
8	and equipment			

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### 3 Execution of anticorrosion works

#### 3.1 General requirements

During the surface preparation and painting process, proper ventilation is required to prevent moisture condensation.

Due to the content of toxic components in coating materials, to ensure safe working conditions resulting from health and safety regulations, forced ventilation of tanks and apparatus enclosed during the entire period of works is required.

According to the technical data sheet of the product, the appropriate temperature of the substrate should be maintained during application and the entire curing process.

For connection stainless steel with carbon steel, stainless steel shall be painted 50mm on the section behind the weld zone. In the case of piping and pressure vessels, the coating on a part of stainless steel must not contain metallic zinc.

#### 3.2 Surface preparation before abrasive blasting

Before blasting new equipment, pipes, steel constructions, check whether all welds and other uneven surfaces have been polished, weld spatter removed, sharp edges rounded to min 2mm radius. Surfaces hardened by thermal treatment (e.g. due to cutting with a burner) shall be grinded to remove hardened surfaces preventing proper surface preparation and giving it right roughness in abrasive blasting. The required surface preparation for new construction shall be P3 according to ISO 8501-3.

Surfaces shall be free from any contaminations (e.g. oils, salts, grease etc.). The surface should be washed with a stream of water with addition of detergent, emulsifier or a ready degreasing detergent accepted by the manufacturer of coating materials, until all contaminations in each section of the structure are removed. After washing, rinse the entire surface with clean water and dry it.

During the preparation of surface for painting, follow the recommendations included in the PN-EN ISO 12944-4 standard.

In addition to hot dip galvanized surfaces, depending on the condition of the surface, before painting, galvanized elements should be cleaned from mechanical impurities (including zinc corrosion products, white rust), degreased or washed with ammonia solution (1-2%) with the addition of detergents and after drying, brushed.

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### 3.3 Blasting

The abrasive material must be dry, clean and free from contaminants that could impair the quality of the coating. The size of the abrasive particles must ensure that the profile is in line with the requirements of the documentation.

It is not allowed to use quartz sand in dry abrasive blasting.

Required steel surface purity, cleaned by abrasive blast cleaning to a degree of at least Sa 2½ according to PN-EN ISO 8501-1, the surface must be the Sa 2 ½ level up to the application of the first coating layer.

Roughness of cleaned surfaces should have an intermediate profile (Medium), sharp edged pattern G (Grit) according to PN-EN ISO 8503-2.

After cleaning, vacuum the surface by sucking up the debris with an industrial vacuum cleaner or by blowing with compressed air. Pollution should not exceed grade 2 according to PN-EN ISO 8502-3.

On abrasive blasted surface the maximum content of soluble impurities on the blasted surface as sampled using PN-EN ISO 8502-6 and distilled water, shall not exceed a conductivity measured in accordance with PN-EN ISO 8502-9 corresponding to a NaCl content of 50 mg/m<sup>2</sup>.

If this amount is exceeded, the surface must be washed again after abrasive blasting.

### 3.4 Coating application


The process of applying paints should be carried out in accordance with the conditions given in the instructions for use of paint products. Paints should be prepared in accordance with the guidelines contained in the technical sheets. Coating colors should contrast with each other.

The products used for painting should be in shelf life. Use mechanical agitators to mix paints.

If full curing does not occur at ambient temperature, annealing should be provided to cure the product.

In the case of using products in quantities smaller than the factory sets, the proportion of the base - hardener by volume or by weight should be accurately measured.

Equipment for hydrodynamic painting should be technically efficient and suitable for the sprayed products.

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The nozzles should not be worn, with a diameter consistent with the requirements for individual products and the angle selected for the shape of the painted elements.

It is necessary to set the "wet paint thickness" before painting, and during painting periodically check the thickness of the "wet paint layer" using the method according to the requirements of PN-EN ISO 2808.

Time intervals should be kept according to the technical sheets.

The coating should not have defects such as:

- overthickness, stains, curtains;
- lack of thickness, holidays;
- blisters, pinholes, craters;
- painted inclusions such as: dust, abrasive, dry spray, etc.

Application by roller of the first layer is not permitted. When applying with a brush, make sure that the coating is as smooth as possible and the thickness is uniform.

Painted structures should be protected against atmospheric precipitation, strong sunlight, moisture condensation, dirt, damage and other unfavorable factors during the painting and curing operations of the applied coatings.

### 3.5 Coating works acceptance

Acceptance by the Contractor's Quality Control with the participation of the Supervision Inspector or a person appointed on behalf of ORLEN S.A. should take place at every stage of the decay work, the detailed inspection plan is presented in Table 3.

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**Table 1. Inspection plan**

Test type	Method	Frequency	Acceptance criteria	Consequence
Environmental conditions	Ambient and steel temperature, relative humidity, dew point tests	Before start and 2 times per shift	In accordance with specification	No blasting and coating
Visual examination	PN-EN ISO 8501-3	100% of all surfaces	In accordance with specification	Defects to be repaired
Cleanliness	PN-EN ISO 8501-1 PN-EN ISO 8501-2	100% of all surfaces	In accordance with specification	Reblasting
	PN-EN ISO 8502-3	Spot checks	Maximum quantity of contaminations- 2	Recleaning
Salt test	PN-EN ISO 8502-6 PN-EN ISO 8502-9	Spot checks	Maximum conductivity corresponding to 50 mg/m <sup>2</sup> NaCl	Repeated washing with potable water
Roughness	PN-EN ISO 8503-2	Once per 100 m <sup>2</sup>	Profil G - Medium	Reblasting
Curing test (for Zn silicate)	ASTM D4752	Once per 100 m <sup>2</sup>	Rating 4 to 5	Allow to cure
Visual examination of coating	Visual assessment curing, presence of inclusions, pinholes, saggings, holidays and other coating defects	100% of Surface after each coat	In accordance with specification	Defects to be repaired
Dry film thickness	PN-EN ISO 19840, calibration on smooth surface	In accordance with specification, if not specified, in accordance with PN-EN ISO 19840	In accordance with specification, if not specified, in accordance with PN-EN ISO 19840	Repair coating with the same material, recoating***

\*\*\*In case of low DFT ethyl-zinc silicate paints, it is essential to follow the manufacturer's instructions. In case of multicoat system with ethyl-zinc silicate paints as primer MEK test should be done before start painting next layer. Test shall be done in accordance with ASTM D4752 Standard. The place to be tested is rinsed with clean water to remove any mechanical impurities, then with a white, cotton rubber moistened with methyl ethyl ketone (MEK), rub on the surface to be tested with a 50-fold reciprocating movement over a length of approx. 150 mm. Minimum acceptance level to painting next layer – 4.

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Acceptance criteria for coating thickness and painting system in accordance with PN-ISO 19840:

- The arithmetic average of all individual dry film thicknesses should be equal to or greater than the nominal dry film thickness (NDFT).
- All single dry film thicknesses should be equal to or greater than 80% NDFT.
- Single dry film thicknesses are assumed between 80% NDFT and NDFT, provided that the number of these measurements is less than 20% of the total number of single measurements.
- All individual dry film thicknesses should be less than or equal to the set maximum dry film thickness. If it has not been determined, see PN-EN ISO 12944-5.
- In special case upon request ORLEN S.A. Inspector required minimum DFT shall be NDFT.

### 3.6 Storage and transport conditions

It is recommended to fully cure the paint coatings under the roof before transporting.

Curing of paint coatings should proceed in accordance with the requirements given in the use of the product instructions.


Painted elements during storage and transport must be protected against coating paint damage. The stored construction elements should be laid on appropriate pads above ground level in a way that prevents water from accumulating in cavities and blind openings. If the structure does not have loading handles, then special belts or soft pads should be used.

### 3.7 Repairs after instalation

The surface prepared for repairs should be dry, free from grease and dust. Blunt sharp edges and remove the welding spatter to a state consistent with conditions of surface before blast cleaning.

Steel surfaces in places of paint coating damage caused due to burns and mechanical damage, etc., should be cleaned by abrasive blasting to the originally assumed degree of cleaning in accordance with PN ISO 8501-1. In technically justified cases, after consultation with the investor and supplier of coating materials, it is allowed to lower the degree of surface preparation to PMa or PSt 3 (manual-mechanical methods) in accordance with PN-EN ISO 8501-2. In places with a lower degree of surface preparation, use coating material compatible with lower surface preparation grade.



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The coating to repainted must be grinded and the edges of the remaining well-adhesive coating must be feathered.

Thickness in the places of repairs must meet the requirements set for the painting system.

Pay attention in places of screw connections, if it comes to the thickness of the coating system. Too high thickness of the coating at the points of screw connections may result in an increased range of damage to the coating during assembly process of the structure.

### **3.8 Final acceptance of protective coating**

The final acceptance should take place on the construction site after the completion of the repairs, after the assembly of the elements.

### **3.9 As-built Documentation**

The Contractor is obligated to keep quality control protocols according to Inspection Plan (table 3.). When assessing the coverage on structures, each stage of works should first be accepted by the contractor's quality control and then presented to the inspector's supervisor for inspection. Contractor is responsible for quality control of the entire process of corrosion protection application. In the case of reference areas, the performance protocol is attached to documentation. This protocol is made by producer / supplier coating material and shall be confirmed by the contractor and investor.

The results of the quality control assessment are transferred to the investor in the form of the Anticorrosion Protection Card (Attachment no 1) with attached dust test in accordance to PN-EN ISO 8502-3 (Attachment no 2) and salt tests in accordance to PN-EN ISO 8502-6/9 and printed out DFT results from DFT gauge. Template of cards and protocols contains point 8. It is possible to use own template of cards and protocols, as long as they according to Inspection Plan. The contractor is required to attach product quality certificates as an attachment to the documentation.

Any changes in the technology of work resulting from the lack or limitation of the possibility of execution in accordance with the technology must be confirmed by both parties with a protocol or entry in the construction journal and should be attached to the final documentation.

### **3.10 References areas execution**

Execution of reference areas should be done in accordance with PN-EN ISO 12944-7. The Contractor, in consultation with the ORLEN S.A. Inspector and manufacturer / supplier of coating materials representative, will design reference areas representative for a given structure.



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On the reference areas, the process of surface treatment, painting and curing/ drying of coatings will be carried out under the supervision of the ORLEN S.A. Inspector, manufacturer/ supplier of coating materials representative and contractor. The reference surfaces must be marked and easy to identify after assembly on the site. The acceptance also covers corrections made on the reference surface after assembly at the construction site.

**Table 4. Number of reference areas**

Size of structure (painted area) m <sup>2</sup>	Recommended maximum number of reference areas	Recommended maximum percentage of reference area relative to total area of structure %
≤ 5000	1	0,3
> 5000 ≤ 10000	2	0,3
>10000 ≤ 25000	3	0,2
> 25000 ≤ 50000	4	0,15
> 50000	5	0,1

## 4 Health and Safety Recommendations

The works should be carried out in compliance with applicable rules and regulations in the field of occupational health and safety and fire protection. Workers employed on execution of anticorrosion work should be trained in HSE rules with particular attention on specific threats resulting from this type of work.

Workers should be equipped in personal protective equipment such as:

- protective glasses,
- protective helmets,
- harness and cables at works on heights,
- blasting helmet with air supply – during blasting,
- protective boots and work clothes,
- dust half mask – at work in dusted areas
- half mask with filters – during brush painting
- full face mask with filters or air supply – during spray painting.

The blasting equipment should be set up with a system that allows to close flow of abrasive from the blasting nozzle directly by the worker performing the process (dead men handles).

Using of personal protection equipment should be controlled by supervisors and HSE department of work supervisor. More detailed information about

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requirements of procedures are contained in Coating Safety Data Sheets for products and Journal of Laws 2004 no 16 item 156.

## 5 Selection of a protective coating systems

Information about selection of a protective coating systems, depending on the type of environment, the degree of surface preparation and the expected durability, commonly used to protect steel constructions against corrosion of painting systems, are contained in the PN-EN ISO 12944-5 standard. The coating system should be tested at least according to PN-EN ISO 12944-6 and should meet the given requirements. The manufacturer's declaration about the durability of the system in a given corrosive category should be confirmed by an independent test facility. New innovative coating technologies can be used, if provide equivalent corrosion protection at lower nominal dry film thicknesses or fewer number of layers, compared to the examples given in PN-EN ISO 12944-5. The same applies to systems that have been tested for many years in field conditions and function well, even though they do not meet current requirements for thickness and number of layers.

For anticorrosive protection of steel structures, equipment and pipes listed in Table 5, exemplary coating systems are specified in Table No. 6.

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**Table 5. Determination of structures, equipment and piping for corrosion protection**

No.	Name of equipment with protected surfaces	Temperature range [°C]	Set symbol from Table 6
Protection of uninsulated surfaces			
1	Constructions such as: flyovers, shelves, columns, beams etc.	up to 60	A
2	Carbon Steel & Low Alloy Piping with supports, external surfaces of stoves, chimneys, flue pipes.	up to 100	A/B
		100-200	C
		200-540	D
3	Piping built into the conduits	up to 200	G
4	Carbon Steel & Low Alloy External surfaces of apparatus, tanks, heat exchangers, columns	up to 100	A/B
		100-200	C
		200-540	D
5	External surfaces of storage tanks	up to 60	A/B
6	Hot dipped galvanized steel surfaces	up to 60	E
Protection of insulated surfaces			
7	Carbon Steel & Low Alloy columns, channels, tanks, heat exchangers, piping.	up to 200	H
		200-540	D
8	Stainless steel columns, channels, tanks, heat exchangers, piping.	up to 150	F
Surfaces with fire protection			
9	Surfaces with cement based fire protection	According to European technical approval or national technical assessment/ technical approval	I
10	Surfaces with epoxy based fire protection	According to European technical approval or national technical assessment/ technical approval	J
Repair of the primer			
11	Repair of the primer according to the specification of the painting material supplier. Materials for use on less-prepared surfaces, (i.e. those not requiring blast-cleaning), are preferred.		
Internal surfaces			
12	If assumed in the design specification, the coatings for the internal surfaces of the equipment are selected individually depending on the type of medium.		

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**Table 6. Coating systems examples**

No.	Sym- bol of a set	The type of products included in the coating system	Surface preparation according to PN-EN ISO 8501-1	Num-ber of layers	Nominal dry film thick- ness [μm]	Nominal dry film thickness of the coating system [μm]
1	A	1. Zinc rich epoxy primer	Sa 2½	1	80	260
		2. High build epoxy coating with barrier pigment		1	120	
		3. Polyurethane (aliphatic)****		1	60	
2	B	1. Epoxy primer with zinc phosphate	Sa 2½	1	120	300
		2. Epoxy coating with barrier pigment		1	120	
		3. Polyurethane (aliphatic)****		1	60	
3	C	1. Inorganic zinc rich silicate	Sa 2½	1	70	120
		2. Silicone, silicone-acrylic mixed or other heat-resistant up to 200°C		2	50	
4	D	1. Inorganic zinc rich silicate	Sa 2½	1	70	100
		2. Silicone or other heat-resistant up to 540°C		2	30	
5	E	1. Epoxy on a hot dip galvanized substrate	dry, degreased, free of zinc corrosion	1	60	200
		2. High build epoxy coating with barrier pigment		1	80	
		3. Polyurethane (aliphatic)****		1	60	
6	F	1. Epoxy designed for CUI or other special heat-resistant up to 175°C	Abrasive blast cleaned to the appropriate roughness profile in accordance with the technical data sheet	1	100	200
		2. Epoxy designed for CUI or other special heat-resistant up to 175°C		1	100	
7	G	1. Inorganic zinc rich silicate	Sa 2½	1	70	350
		2. Epoxy designed for CUI or other special heat-resistant up to 200°C		2	280	

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No.	Sym- bol of a set	The type of products included in the coating system	Surface preparation according to PN-EN ISO 8501-1	Num-ber of layers	Nominal dry film thick- ness [μm]	Nominal dry film thickness of the coating system [μm]
8	H	1. Epoxy designed for CUI or other special heat-resistant up to 200°C	Sa 2½	2	100	200
		2. Epoxy designed for CUI or other special heat-resistant up to 200°C			100	
9	I	1. Epoxy primer with zinc phosphate	Sa 2½	1	100	200
		2. High build epoxy coating with barrier pigment		1	100	
		3. Cement-based fire protection		Based on the executive project agreed with fire protection expert and Commander of the Company Fire Brigade PKN Orlen S.A.		
10	J	1. Epoxy primer accepted in technical approval of fire protection	Sa 2½	1	60	60
		2. Epoxy-based fire protection		Based on the executive project agreed with fire protection expert and Commander of the Company Fire Brigade PKN Orlen S.A.		

\*\*\*\* For polyurethane paints it is possible to change for polysiloxane paints.

J, K - System and supplier of coating materials should be accepted in the instruction/ authorization in fire protection system documentation.

## 6 Qualification of companies and personnel

### 6.1 Contractors

Companies specified with corrosion protection in accordance with ORLEN S.A. should present references in the form of documented experience in the organization, planning and execution of work in similar size and complexity.

### 6.2 Supervisors and operators

Contractor's supervisors should have experience and certificates confirming their knowledge in anticorrosion protection field.

Operators should be trained by supervisors in quality requirements of ORLEN S.A. and by producer/ provider of coating materials.






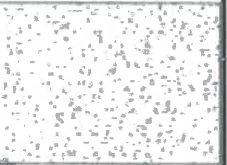
## 7 Derogation

Any derogation from the above standards, norms and related documents require ORLEN S.A. approval.



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## 9 Appendix 2 – Dust test

	Dust test according to PN-EN ISO 8502-3		Order no: .....			
Object / Equipment / Line: .....			Test no: .....			
A  B  C  D  E						
	1	2	3	4	5	
						
	A B C D E					Average
Quantity						
Size						
Type of tape: _____ Type of surface: _____						
Other: _____ Date and time of test: _____						



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## 10 Appendix 3 – Salt test

	Salt test according to PN-EN ISO 8502-6/9		Order no:  .....
Object / Equipment / Line:  .....		Test no:  .....	
Type and size of path:			
Volume of injection water:			
Duration of the test:			
Number of cycles:			
Date and time of test:			
Surface temperature:**			
Air temperature:**			
Humidity:**			
Other:			
** If available			
Measure value - Zero value = Result			
	Measure value μS/cm	Zero value μS/cm	Result mg/m²
A			
B			
C			
D			
E			

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## 11 Standard's change and update sheet

NO	THE CONTENT OF THE ENTRY, CHANGE	EDITION	RELEASE DATE
1	First document release	1	01.08.2018
2	The standards and colors of the equipment were updated, attachments were changed, the document was supplemented with points related to: work planning, health and safety, selection of anti-corrosion system, fire protection, test required table, piping in pipe culverts, qualifications of contractors.	2	10.03.2020
3	The standards, tables with coating systems and requirements for Surface preparation before painting were updated. Scope of application of the document were detailed.	3	24.03.2021
4	Added 2 norms, updated coating system thickness on galvanized surfaces, updated point for corrosion protection of water cooled heat exchangers tube bundle, updated norm in the section on technological and storage tanks.	4	24.06.2021
5	Norms and requirements for corrosion protection of stainless steel surfaces have been updated, color requirements for electric motors, pumps, coupling covers and other rotating parts have been removed, translation upgrade.	5	15.12.2022
6	The name of the company was changed from PKN Orlen S.A. on Orlen S.A. Updated 2 standards: zinc coatings applied to steel and cast iron products by immersion method and assessment of the degree of peeling of the coatings.	6	31.08.2023