



Technical handbook



BARIL



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Appendix:

Exposure assessment

Appendix: Exposure assessment

Exposure assessment

When paint products containing solvents, i.e. volatile organic compounds (VOC), are used in an enclosed space, the MAC value (maximum acceptable concentration) for the solvents may be exceeded. With the help of a mathematical model, it is possible to carry out calculations to determine whether the MAC value concerned, solely for VOCs, is exceeded.

Use of the mathematical model

This mathematical model is made available as a tool on the website of Baril Coatings BV: www.baril.nl. You can log into the site by entering your account payment identification number with us in combination with your postal code. You are not required to use this model, and if you do so, it is entirely at your own risk and liability. In any case, Baril Coatings will not accept any liability for any damage whatsoever resulting from the use of this model.

Chapter 1: General terms and conditions of Baril Coatings B.V for protective coatings on steel

In all cases not covered by these terms and conditions, the NPR7452 terms and conditions will apply.

1.1 Before blasting

- All welding spatter and welding slag must be removed immediately after blasting.
- Round off sharp edges and drill holes to a radius of 2 to 3 millimeters.
- Any openings between welding spots on single-welded parts need to be sealed using a recoatable kit.
- Before blasting, the surface must be free of oil and grease to minimize the risk of poor adhesion, particularly in the case of automatic blasting processes.

1.2 During blasting

- Ensure that the required degree of cleanliness and roughness is realized while taking into account that the blasting profile may not exceed 70 μm .
- Although it has never clearly been proven that roughness improves adhesion of the paint to the substrate, we recommend the realization of a specific minimum roughness, especially in the case of automatic blasting processes. Particularly for high-build primers (zinc dust paints), a minimum Ra value of 25 μm should be realized. Rugotest N03; N11-A. (also see section 16.16 page 48).
- With regard to surface preparation, please refer to NPR 7452.

Type of surface	Standard	Chapter	Section
Bare steel	NPR 7452	4	6.2.3.
Steel hot dip galvanized	NPR 7452	4	12
Steel sendzimir galvanized	NPR 7452	4	12
Steel metal-sprayed	NPR 7452	4	13
Steel St3 hand derusted	NPR 7452	4	6.2.2.

Type of product	Ra value	Rugotest N0
Zinc dust compounds	20-25 μm	N 11-A
Zinc-rich primers	15-20 μm	N 11-A
Quick drying transport or welding primers	10-15 μm	N 10-A
Quick drying alkyd primers and coatings	8-12,5 μm	N 9-A/b rough grit
Two-component primers and coatings	5-10 μm	N 9-A

1.3 After blasting

- Store blasted materials under conditions in which moisture, (spray) dust and other undesirable influences cannot affect the quality of the paint system.
- Make sure the blasted surface is dry and free of dust, oil and grease before starting to apply the coating material.
- Apply the first coat as soon as possible after blasting to minimize formation of corrosion.



1.4 During application

- a. Paint products may be applied only at temperatures between 5°C and 35°C. When using two-component products, we recommend a minimum temperature of 15°C to ensure optimal chemical reaction between both components unless specified otherwise in the product data sheets. The relative humidity may not exceed 85% and the surface temperature should be at least 3°C above the dew point.
- b. During application, drying and/or curing, adequate ventilation must be provided.
- c. Work in accordance with the specified drying times between the separate coats of the coating system.
- d. Ensure that the required nominal film thickness is realized (see section 16.14 page 47). We recommend that the required film thickness not be exceeded by more than 25% per coat. The required film thickness must also be realized on edges, corners and difficult to reach places.
- e. Use the thinning procedures specified by Baril. Warrantees will not apply if it turns out that application of thinning procedures other than the ones specified can cause problems.
- f. With regard to the choice of application equipment, we recommend the use of airmix and/or electrostatic spraying. These offer a reduction in paint consumption of 10% and 25% respectively depending upon the nature of the object and the settings used.
- g. When choosing the colours RAL-9006 and RAL-9007 as well as the other aluminium and/or Miox colours for finish coatings, one should take into account that optical colour differences may appear if the top coating later needs to be touched up via brush/roller application to repair local damage.

1.5 Storage

- a. For the required conditions during drying, please refer to 4a.
- b. In case of indoor storage, protect the surface from spray dust or other undesirable influences.
- c. Outdoor storage is permissible only after complete drying/curing of the paint system in order to minimize the effect of rain and/or condensation. If the paint system has not yet become fully dried/cured, the coated materials must be covered.

1.6 Transport

- a. Transport of the coated parts to the building site may take place only after sufficient drying and/or curing of the paint system has taken place.
- b. During transport and storage, make sure there are sufficient protective elements inserted between the various coated parts.
- c. Use canvas or canvas covered slings and straps during transport and assembly.

1.7 Assembly

- a. Use metallized bolts and nuts for assembling coated parts.
- b. Any mechanical damage resulting from transport should be reworked in accordance with the rework instructions.
- c. Mechanical damage caused by the use of parkers, blind rivets etc. are excluded from any warrantees that may apply.



1.8 Coating contractor

- a. When using Baril coating products, the coating contractor must be familiar with the complete paint specifications, the most recently updated product data sheets, health and safety data, and the general terms and conditions of Baril Coatings B.V. for protective coatings on steel.
- b. Only products in unopened original Baril packaging with genuine Baril labelling may be used.

1.9 Maintenance projects

- a. All performance specifications within B.A.S. requires long-term maintenance. A maintenance system will be recommended and made available for all new building systems. From the perspective of corrosion protection, the first maintenance activities on a paint system should be carried out when its exterior surface has progressed to the point where it complies with class Ri 3 (= 1% surface rust) of the ISO 8618-3 standard. However, more frequent maintenance is recommended from the perspective of aesthetic factors such as calcification, discolouration, loss of gloss etc. Before a maintenance system can be implemented, it is very important to obtain information on the substrate conditions and climatological circumstances at the project location. Based on this information, a suitable method of surface preparation can then be recommended to ensure an optimum end result. In case of any doubts or insufficient information regarding the existing situation (substrate), we recommend attaching test surfaces to the existing system (DIN55928) and evaluating these after a predetermined interval with regard to adhesion and/or other aspects such as colour, gloss etc.
- b. The original colours applied to existing projects may change over time under the influence of aging and environmental factors.

1.10 General

- a. For the terms and conditions that apply to the treatment of hot dip galvanized steel structures, please refer to the Dutch national NPR 5254 guideline for the industrial application of organic coatings on hot dip galvanized steel (Duplex system).
- b. All our tenders and agreements are subject to the general terms and conditions of sale for paints and printing inks as registered with the District Court in Amsterdam.

Chapter 2: Supervision & technical support

Baril Coatings offers more than just advice. We offer a total service solution to the principal, the architect, the main contractor and the painting contractor.

In order to ensure the required performance in terms of durability, Baril Coatings offers full technical support and supervision during implementation and completion of the application process, all in accordance with the Dutch national NPR 7452 guideline.

This service must be requested at least one week before the start of the application process together with submission of the recommendation provided with regard to the paint system. After confirmation of the painting specifications recommendation, Baril Coatings and the painting contractor agree on the criteria and items to be reported as described below.

The report includes the following descriptions and inspection results in accordance with Dutch national guideline NPR 7452 chapter 7:

- selection of pre-treatment method and correct execution
- selection of application method and execution
- application conditions
- recommended coating system
- type of climate at project location
- Baril products used and related batch numbers
- film thickness realized
- number of measurements
- nature of the object
- principal
- painting contractor

Or section

- e. Subject and field of application
- f. References
- g. Conditions for execution of the painting work
- h. Painting material
- i. Execution of the painting work
- j. Inspection of the painting work
- k. Reference areas

The supervision and support provided by Baril Coatings does not relieve the painting contractor of his responsibility for the work carried out by him. The painting contractor must thoroughly familiarize himself with the most recently updated product data sheets and the general terms and conditions of Baril Coatings B.V. for protective coatings on steel. Baril Coatings Baril Coatings is not responsible for application and the application conditions. The final durability depends largely on factors that are outside our control and for that reason we cannot accept any liability in that regard.

If all the requirements within the painting specifications have been met, a warranty statement can be drawn up. Without a copy of the inspection/supervision report, no warranty will be issued.

In case of any reclamation, it is important to register the batch numbers of the relevant products.

Without these references, reclamations cannot be dealt with.

Parts of a project that are not covered by the painting specification are excluded from any warranty.



Chapter 3: Maintenance

Suitable and timely maintenance is required to ensure optimum performance of a coating system. However, choosing a coating system for the purpose of maintaining an existing object is more complicated than for a new object.

The choice of a suitable maintenance system is based on the following criteria:

- atmospheric circumstances
- nature of the existing coating
- type and condition of the existing coating
- nature and type of substrate

In general, epoxies, chlorinated rubbers, vinyls or polyurethanes should not be applied over alkyd paints out of concern for possible softening and poor adhesion.

Alkyd based paints should not be applied over aged chlorinated rubber and vinyl paint systems out of concern for possible cracking. They should also not be applied over zinc-rich primers in humid conditions out of concern for the risk of saponification

For each maintenance specification, the compatibility of the maintenance coating system with the existing coating system must be known or else determined with the help of a test surface.

Some of the most common paint failures are:

- cracking
- blistering
- poor adhesion
- corrosion

It is important to determine the cause of failure in a coating system, especially if it occurs at an early stage. The atmospheric circumstances then need to be determined anew to be able to recommend a suitable paint system. Inferior paint films need to be removed in case of poor adhesion. Aged but intact paint films need sanding at all times to secure proper adhesion of the new paint system.

Chapter 4: Corrosion

Steel has a great many practical applications due to its strength and the ease with which it can be worked. However, a disadvantage of this metal is that it is subject to corrosion, i.e. rust formation. Steel consists largely of iron and small quantities of carbon, silicon, manganese, aluminium, nickel, chromium, copper, molybdenum and vanadium. The exact composition depends upon the specific target application. The resistance to corrosion also depends largely on the specific composition of the steel.

The production of steel components is based on rolling out large blocks of steel at high temperatures. During the cooling process, the metal surface oxidizes leading to the formation of oxide scale or mill scale. Steel plates with mill scale are first immersed in a pickling bath to remove the mill scale, after which the plate is rolled out at room temperature to the desired thickness. After the resulting sheets have gone through a heat treatment in an oxygen-free environment, they are covered in a film of oil.

As mentioned above, steel reacts rather quickly with oxygen at high temperatures. At temperatures under 400°C, the reaction between steel and oxygen proceeds very slowly. The fact that steel corrodes relatively quickly at room temperature is based on chemical reactions involving water.

Corrosion is therefore an undesirable surface-based electrochemical or chemical process that damages metal, and it can be combated in many different ways. One of the most widely used methods is the application of suitable coating systems, generally in the form of paints. A suitable coating system is capable of blocking moisture and oxygen from contact with the metal surface, thereby preventing corrosion. In addition, a suitable coating system can greatly influence the factors which reduce the speed at which corrosion takes place. As a result, a suitable coating system can significantly increase the value of the metal concerned by extending its usable lifespan and significantly improving its appearance. In this regard, it should also be noted that the form and design of metal objects also impact the ability of a coating system to prevent corrosion.

The following characteristics have a negative impact in terms of corrosion:

- the presence of sharp edges and corners
- places where water and dirt can accumulate
- discontinuous welding seams, allowing moist air to penetrate beneath the coating
- cracks and other difficult to reach places



4.1 Protecting metal

If a metal object is exposed outdoors to the climate, it will rust. In order to prevent rust formation, the surface of the object is treated in such a fashion as to provide it with protection. The level of protection should be in line with the expected or required life span of the object. An additional and significant benefit is that this type of protection generally also improves the appearance of the metal object. As a result, this type of surface treatment makes the metal more suitable for use and gives added value to the product.

In order to make a choice from the many similar types of surface treatments available, we need to look at the intended use of the object. It is this use which largely determines what conditions and factors the object concerned will be exposed to. The most important factors upon which such a choice can be based involve:

- desired lifespan
- influence of climate
- influence of mechanical factors

4.2 Desired lifespan

The surface treatment chosen should provide a level of protection in line with the lifespan of the object. Objects with a very long life span need to be reconditioned several times. This is, for example, the case with steel constructions, ships, bridges, and building façades. For such types of capital goods, one needs to choose a protective system that will provide protection for as long as possible.

4.3 Influence of climate

The climate greatly impacts the lifespan of a coating system.

When used outdoors, a coating system will be exposed to the influence of ultraviolet light, which is very destructive for a great many binding agents. However, this effect can largely be circumvented via the use of plate- and needle-shaped pigments such as aluminium and micaceous iron oxide.

4.4 Moisture

Continual fluctuations in humidity exert a great deal of pressure on a coating system. These types of conditions occur, for example, when it rains and in day-night cycles during which temperature fluctuations continually lead to the formation of condensation.

4.5 Corrosive influences

Contaminants from the atmosphere can also exert a great deal of pressure on a coating system. Such contaminants are common in industrial and maritime climates. At present, the situation is such that the climate in all Western countries can be considered as being contaminated.

Chapter 5: Removal of rust, mill scale and contaminants

To ensure good results, it is essential for rust, mill scale and contaminants such as grease to be removed from the steel before application of the protective coatings.

5.1 Rust

The microporous structure of rust allows it to attract and store a great many contaminants from the air, which further accelerate the process of corrosion. The relative softness of the surface rust layer would lead one to think that it can easily be removed. However, its adhesion to the steel surface is such that the last remainders of rust in particular can be removed effectively only via the appropriate work methods. A complete removal of rust is needed to ensure that, after further follow-up treatments, no so-called subsurface rust develops, as this would destroy the protective coating applied later.

5.2 Mill scale

Mill scale is a kind of skin that develops on the surface of steel as a result of the high temperature used when steel is rolled out. It is grey-blue to black in colour. This skin is generally composed of layers of various iron oxides and is comparable to the iron oxide flakes that break off in the smithy (hammer scales) or the layer of oxides formed when steel undergoes heat treatment or welding. Mill scale and hammer scales are significantly thicker than the oxide layers formed when steel undergoes heat treatment or welding, but all these layers have a very hard and compact structure. If these oxide layers were continuous and unbroken, they would provide the metal with an excellent form of protection. However, due to the formation of shrinkage cracks, the oxide skin does not completely enclose the metal. In addition, the oxides are nobler than steel, which means that they can also cause the steel to corrode. As is the case with rust, all scale must therefore be completely removed, as no protective coating would be resistant to particles left behind of rust, hammer scale, mill scale, heat scale or welding scale. The performance of the protective coatings applied at a later stage therefore depends largely on the effectiveness with which the steel surface is initially cleaned.

The removal of rust and mill scale can be carried out by:

- pickling
- flame blasting
- mechanical cleaning
- wet blasting
- high-pressure water jetting
- special blast cleaning methods

5.3 Pickling

Pickling is a chemical method for removing the layer of mill scale. When sulfuric or phosphoric acid is used, it takes place in heated baths. When hydrochloric acid is used, it is done in unheated baths. Large acid-resistant pickling tubs are therefore needed for the process. A complete treatment always consists of three immersions: first in one of the above-mentioned acid baths, followed by a warm water bath to rinse any remaining acid from the steel surface, and finally a bath in a dilute solution of warm phosphoric acid to create a thin layer of iron phosphate on the surface of the steel. This phosphate layer slows down rust formation and provides a better surface for adhesion during further treatments. In order to prevent acid from accumulating in specific parts of an object, these parts are dealt with accordingly before the object is assembled. Pickling in hydrochloric acid is used primarily for galvanized steel.



5.4 Flame blasting

Flame blasting has various disadvantages, which is why this method is no longer very common. By subjecting the steel to a hot flame fed by a mixture of oxygen and acetylene or oxygen and propane, the layer of mill scale suddenly expands and breaks while at the same time the moisture present is quickly converted into steam, thereby removing the rust. However, this never removes all the rust, which is why this method is only suitable as a form of preliminary cleaning. But even in that case, flame blasting still suffers from the disadvantage that the steel may become distorted as a result of intense heat applied locally.

Chapter 6: Blast cleaning

Blast cleaning methods can be divided into three different categories:

- airblasting
- turbine blasting
- wet blasting

6.1 Airblasting

Airblasting is a method whereby the abrasive blasting material is propelled onto the steel surface with the help of compressed air. The abrasive originally used for this purpose, sand, was later replaced by other materials, but the process is still often referred to as sandblasting. The abrasives now used can be divided into abrasives for one-time use and recyclable abrasives. When blasting large structures in the open air, the abrasive is used only once. Corundum is the best abrasive and can be used several times. Due to its higher price, it is not often used for outdoor blasting work, as it can then not be recovered. Chilled iron shot or grit and steel shot or grit are also used, especially for turbine blasting. Although mobile blasting equipment is available, for example for repair work, the construction industry mainly uses fixed installations which are installed on site at metal treatment firms.

6.2 Turbine blasting

In turbine blasting, the abrasive material is propelled onto the steel surface with the help of turbines. This type of equipment can be integrated into entire processing lines, in which large numbers of objects are coated with a primer immediately after the blasting process in order to prevent new rust formation. As the effect of turbine blasting depends upon the weight of the propelled material, coarser abrasive grades of steel grit or shot, whereas for manually operated blasting cabins chilled iron grit is also used.

6.3 Wet blasting

Wet blasting, also referred to as liquid honing, is not commonly used in the construction industry. Special equipment is available for wet blasting. This method can be used for mechanically cleaning new as well as old steel surfaces and for roughing up old intact coatings in order to prepare them for the application of new coating layers. In wet blasting, water is sprayed onto the steel surface under high pressure, with or without the addition of an abrasive. As the steel surface will very quickly begin to rust again after the treatment, additional treatment is quickly necessary. Wet blasting is also used when the formation of fine particles must be avoided or when the formation of sparks must be avoided due to the risk of fire and/or explosion.

6.4 High-pressure water blasting

High-pressure wet blasting differs from other blasting methods, as it uses the energy of the water which is jetted on to the steel surface under high pressure (500 - 2000 bar). High pressure water blasting, with or without the addition of an abrasive, makes it possible to completely clean a steel surface.

When treating existing objects, this method also makes it possible to remove only the damaged top layer and leave the base layer intact. High-pressure water blasting has the additional advantage that it also removes any (invisible) residues of chlorides and sulfates from the metal surface.

This blasting method, also referred to in the trade as "Hydro Jetting," is gaining in popularity.

6.5 Special blast cleaning methods

There are quite a number of special blast cleaning methods, many of which have found only limited application until now. These special blasting methods can be divided into the following categories:

- blasting in a wet environment to prevent fine particle formation
- zinc blasting with zinc-coated abrasive in order to simultaneously apply a protective coating
- blasting and phosphatising in a single process step
- blasting with a flame in order to achieve simultaneous drying
- high-pressure water blasting without using an abrasive agent
- blasting and coating simultaneously
- ice blasting

6.6 Blasting standards

In view of the large diversity of blasting agents and methods, it is only logical that various requirements have been formulated which must be complied with. These requirements also depend to a large extent on the treatment applied after the blasting process, although the latter generally consists of the application of a finish coating of paint. Various standards exist in this regard which also differ to some extent. In the Netherlands, the most common blasting standard used is the ISO (International Organization for Standardization) standard. In addition to blasting standards, there are also standards for so-called hand tool cleaning. As the ISO standard is the one most commonly used in the Netherlands, it will be fully dealt with. The ISO standard is available from the **Nederlands Normalisatie Instituut** (Dutch Normalization Institute).


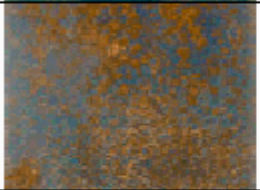


6.7 ISO-8501-1:1988

ISO-8501-1:1988 standard for the rust grading of steel surfaces and standards for the preliminary treatment of these surfaces before they are treated with (corrosion-control) paint. This standard was formulated by the **Swedish Corrosion Institute** in cooperation with the **American Society for Testing and Materials (ASTM)**, and the **Steel Structures Painting Council (SSPC)**, and is used in specifications regarding the pre-treatment of surfaces before they are painted. The specifications in this standard apply to:

- the surfaces of hot-rolled steel in four different rust grades (A, B, C en D)
- the same surfaces which have been pre-treated in accordance with two different surface quality standards: hand tool cleaning (**St 2**) and power tool cleaning (**St 3**) with power wire brushes, power impact tools, power sanders etc.
- the same surfaces which have been pre-treated in accordance with four surface quality standards for various types of blast cleaning (**Sa 1**, **Sa 2**, **Sa 2½** and **Sa 3**).

Chapter 7: Preliminary treatment standards

7.1 Scraping and wire-brushing

Rust grade	Pictorial example	Description
A		Steel covered completely with adherent mill scale and with, if any, little rust.
B		Steel surface which has begun to rust and from which the mill scale has begun to flake.
C		Steel surface on which the mill scale has rusted away or from which it can be scrapped, but with little pitting visible to the naked eye.
D		Steel surface on which the mill scale has rusted away and on which considerable pitting is visible to the naked eye.

It is assumed that, before this treatment takes place, the steel surface has been cleaned of dirt, oil and grease and that the worst instances of rust have been removed by chipping.

St 2 Thorough hand scraping, hand wire brushing, hand sanding, etc.: This treatment should remove all loose mill scale, rust, paint and contaminants. Finally, the surface must be cleaned with a vacuum cleaner, clean and dry compressed air, or a clean brush. The substrate should then have a faint metallic sheen. The surface should have the same appearance as illustrated in the **St 2** series of pictures.

St 3 Very thorough hand scraping, hand wire brushing, hand sanding etc.: surface pre-treatment as in **St 2** but much more thorough. After the fine particles have been removed, the surface should have a pronounced metallic sheen. The surface should have the same appearance as illustrated in the **St 3** series of pictures.

7.2 Blast cleaning

It is assumed that, before this treatment takes place, the surface has been cleaned of dirt, oil and grease, and that the worst instances of rust have been removed by chipping.







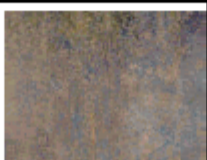









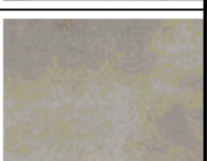

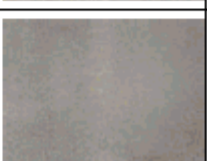
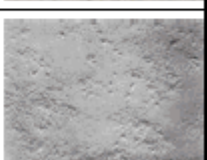
Sa 1 Brush-off blast cleaning: leading to removal of loose mill scale, rust, paint and contaminants.

Sa 2 Thorough (Commercial) blast cleaning: leading to removal of nearly all mill scale, rust, paint and contaminants.

Sa 2½ Very thorough (Near-White) blast cleaning: leading to removal of practically all mill scale, rust, paint and contaminants to such an extent that only slight traces in the form of very light shadows or streaks remain behind.

Sa 3 White metal blast cleaning: leading to complete removal of all mill scale, rust, paint and contaminants.

The following applies in general to **Sa 1**, **Sa 2**, **Sa 2½** and **Sa 3**: finally, the surface must be cleaned with the help of a vacuum cleaner, clean and dry compressed air, or a clean brush. The surface appearance must be the same as the picture illustrating the standard.

Cleaning standard	Initial steel condition (see also table 1).			
	A	B	C	D
St2 – Hand tool cleaning	Not applicable			
St3 - Power tool cleaning	Not applicable			
Sa1 -Brush-off blast	Not applicable			
Sa2 - Commercial blast	Not applicable			
Sa2.5 -Near white metal				
Sa3 - White metal				

Chapter 8: Sanding base surfaces and coatings

This chapter deals with the preparation of surfaces for painting by sanding.

Sanding is a treatment that can be carried out using coarse/or fine sandpaper and with or without the help of a sanding machine.

8.1 Why sanding?

There are various reasons for sanding, including:

- smoothing and levelling out rough/uneven surfaces, irregularities, filler, welding seams etc.
- roughing up existing coating layers and base surfaces to ensure better adhesion
- rust removal

8.2 What type of sanding machine?

The form, material and any finish present of the object to be sanded determines the type of sanding machine to be used.

Type of sanding machine	Type of activity or object sanded
Rotary	
- Oval	- Rust removal
- Roughing up concrete and brickwork	- Removal of old coating layers
Eccentric rotary	
- Oval	- Old coating layers - Primers and coatings
Vibrating	
- Oval	- Blasted objects
- Rectangular	- Old coating layers
- Triangular	- Old coating layers
- Delta-shaped	- Primers and coatings

A sanding system consists of the sanding machine, the sanding pad, and the abrasive agent (paper, disk etc.). The abrasive agent can be attached to the pad via clamps or Velcro or a self-adhesive agent can be used.

We recommend the use of personal protective equipment in the form of a dust mask. The production of harmful dust can also be reduced by using sanding machines with built-in vacuuming functionality or systems with separate dedicated vacuum dust collectors.

8.3 Particle size of abrasive material?

The table below presents an overview of recommended abrasive materials for various types of jobs.

Type of surface	Type of abrasive material
Removing old paint layers	80-120
Rust removal	60-120
Bare steel	120
Hot-dip galvanized steel	280 Scotch Brite, Hamat
Sendzimir galvanized steel	280 Scotch Brite, Hamat
Concrete and brickwork	Fiber 24-36/P 16-P1 20
Plastics	Scotch Brite type A red, Hamat red
Plate material	Scotch Brite type A

8.4 Hand sanding

Hand sanding is very labour-intensive and therefore not an easy job. In addition, the end result is often a surface which is not evenly roughened, leading to uneven adhesion of the paint layer. Although the end result can be acceptable, power sanding remains preferable. The same guidelines apply here as for power sanding.

Chapter 9: Preliminary surface treatment

9.1 Steel

9.1.1 Hot-rolled steel

The surface of hot-rolled steel is characterized by two factors which have a negative impact on the application of a coating system: mill scale and rust.

Both these components are usually removed by blast cleaning.

Cleaning steel by blasting is a well-known concept, and this type of preliminary treatment has been proven to result in the most ideal surface for subsequent application of a coating system.

The cleaning standard most often used in practice, **Sa 2½**, is derived from the **Sa 3** (white metal) standard, as the latter cannot always be realized under all conditions. In addition to these two cleaning standards, there are also the **Sa 2** and **Sa 1** standards, which permit a greater degree of residual surface contamination.

9.1.2 Cold-rolled steel

Cold-rolled steel is generally thinner. In contrast to hot-rolled steel, the surface does not have any mill scale.

The surface of this type of steel is covered with a thin film of oil in order to prevent rust formation.

Before this type of steel may be coated, it goes through a preliminary chemical treatment process. This chemical treatment can be carried out via immersion in a series of baths or in a spray tunnel and is an industrial process. For steel, two types of phosphatizing processes are used in this regard, zinc-based and iron-based phosphatizing. The zinc-based process provides better corrosion control than the iron-based one.

9.2 Galvanized steel

9.2.1 Hot-dip galvanized steel

The hot-dip galvanizing process was originally developed as a method for protecting surfaces from corrosion, whereby durability had to be in line with the expected economic life span of the object. However, the relatively quick degradation of the zinc coating under the influence of present-day atmospheric conditions means that extra protection is required. Several coating systems have also been developed to realize this. However, these coatings also require preliminary surface preparation to ensure optimum adhesion.

9.2.2 Chemical pre-treatment

Chemical pre-treatment can be of the following types: phosphatization, yellow hexavalent chrome passivation, or chrome-free treatment. These types of treatments can be effectively carried out in a series of baths, but in view of the limited lengths of such baths, they can be used only for objects of limited size. In addition, the same type of treatment can be carried out in a spray tunnel.

9.2.3 Mechanical pre-treatment

This consists of brush or sweep blasting the surface with a fine inert abrasive material under low pressure and at a modified nozzle distance from the surface. This is the best method for large units of construction steel. The surface profile resulting from this method improves the adhesion of the coating system to be applied.

9.3. Metal sprayed steel

Metal spraying of steel is a process in which very fine droplets of molten zinc are applied to a steel surface that has been blast cleaned to the **Sa 3** (white metal) standard.

The surface profile of the zinc coating is fairly coarse, and the thickness of the coating will normally vary between 40 and 60 micrometre.

Due, among other factors, to its porous structure, the zinc layer will provide only very limited corrosion resistance if no further coating is applied. It should therefore be viewed as a good but reactive zinc-based primer. It is therefore essential that a further protective coating is applied very quickly.

9.3.1 Sendzimir

The Sendzimir process is an automated hot-dip galvanizing process which provides a zinc coating of 20 - 25 micrometre thickness. This relatively thin layer of zinc provides only limited protection. Particularly for outdoor applications, an additional coating system should be applied to the material.

In most cases, Sendzimir has been chromated in a follow-up treatment by means of hexavalent chromium, and a 'steam-based degreasing method' is considered adequate before application of a further coating. For roof and façade sheeting that has already been installed, a suitable pretreatment consists of steam cleaning and wet blasting.

9.3.2 Zincor

Zincor refers to a galvanically applied coating of zinc with a thickness of 5 -10 micrometre. The surface structure is smooth and closed and goes through a follow-up treatment after galvanization. Before a further coating system can be applied, the surface must undergo pretreatment aimed at removing oil and grease via immersion in a series of baths, via a spray tunnel, or via an alkaline- or steam-based degreasing process.



9.3.3 Aluminium

Aluminium is produced in a great many different qualities in the form of alloys with varying percentages of other metals (such as copper, manganese, zinc and magnesium), depending upon the specific characteristics desired. Soon after it is produced, a layer of oxide is formed on the surface which negatively affects the adhesion of surface coating systems. It is therefore essential for this oxide layer to be removed.

In view of the stringent requirements which the protective coating system needs to comply with, the surface must be optimally prepared beforehand prior to application of the coating system.

This preliminary treatment takes place in a series of baths in which the following steps are implemented one after the other: removal of oil and grease, pickling, and chromium-based or chromium-free passivation with intermediate rinsing.

The thin crystalline passivation layer of chromium salts or chromium-free passivation layer is only a few microns thick but prevents further oxidation of the aluminium and provides a good adhesion surface for the coating system that follows.

9.3.4 Concrete

The protection of concrete objects the help of a coating system may be necessary for a variety of reasons. However, for reasons related to paint technology, this type of material needs to be evaluated completely differently than materials in the metal sector, with a focus on:

- loose bits of concrete;
- alkalinity;
- moisture content;
- laitance.

The above factors all have a negative impact on successful coating application. Objects therefore need to be evaluated accordingly in order to determine a suitable preliminary treatment and coating system.

New concrete generally has to age for a period of 3 to 6 months before alkalinity and moisture content (maximum of 4%) reach acceptable levels and a coating can be applied. In the construction sector (bridges and viaducts), such surfaces are generally best treated by blasting.

Chapter 10: General information on floor finishing

Floors can be finished in a very wide variety of products and materials including: natural stone, double-fired floor tiles and other tiles, linoleum, vinyl, carpeting etc. But floors can also be finished in various types of synthetic coatings. Only the latter option will be discussed here within the framework of the product range supplied by Baril Coatings.

10.1 Floor requirements

The choice of the finish to be applied must also take the specific characteristics of the surface into account. In addition, the surface must satisfy several specific requirements before the finishing process is started:

- The surface must be clean, dry and free of oil and grease. In other words, all foreign elements must be removed in order to facilitate the effective adhesion of the finishing layer. This may require a cleaning and/or preliminary treatment step.
- The surface must be mechanically stable. In other words, the strength at the surface may not (noticeably) differ from the average strength. This is necessary to ensure long-term adhesion, particularly when subjected to mechanical and thermal loads. This prevents separation of the finishing layer together with the top layer of the substrate.
- Whenever possible, 'upwards moisture penetration' must be prevented. In the case of new concrete floors, this can be realized by pouring the concrete on top of an impermeable foil. For concrete floors, the moisture content of the floor may not exceed 3% at the moment that a floor finish is applied which is impermeable to moisture.

10.2 Preliminary treatment of floor

The preliminary treatment of a floor needed to ensure a good finish can be realized physically, chemically or mechanically. The type of treatment chosen or combination of such treatments will depend upon the presence of foreign contaminants, the stability, and the nature of the floor substrate.

Physical cleaning processes are carried out with the help of solvents/stripping agents, which can be used for example to remove paint and/or glue residues. Chemical pretreatment includes the removal of all types of contaminants with the help of neutral, acidic or alkaline cleaning agents, which may or may not be combined. This also includes the use of acid to etch out the surface and thereby increase the surface pore volume and improve future adhesion. Mechanical pretreatment refers to sanding, cutting or roughing up the surface in order to remove the contaminated or weaker top layer of substrate. Various methods are available for achieving this including sanding, very high-pressure water jetting, grit blasting (dry) and sandblasting (wet).



10.3 Concrete floors

For new concrete floors, a laitance layer may be present on the surface, which will then have to be removed with the help of a light blasting procedure (particle-free) or the use of a cement remover or special acid cleaning agents. Depending upon the type of finish desired, monolithic concrete with a closed hardened top layer must be roughened up lightly to facilitate adhesion of the coating system. All the preliminary treatment methods mentioned above may be used for all old and contaminated or damaged concrete floors, in which case the specific method chosen will determine the thickness of the surface layer lost. Cracks in the floor can be caused by all kinds of factors and must be investigated further to determine, for example, whether it is necessary to consider measures such as injections, dilatations etc..

10.4 Finish

When selecting the type and thickness of coating system to be used for finishing a floor, several important criteria must be considered:

- What loads will the system be subjected to?
- What are the aesthetic requirements?
- What is the desired degree of roughness?
- Which type of substrate must be finished?

Chemical loading factors determine the type of synthetic coating chosen and minimum coating thickness. Mechanical as well as thermal loading factors determine the required thickness as well as the hardness of the system in combination with the substrate.

Since many binders are available which may also be used in combination with each other, the range of possibilities is practically unlimited. Solvent-based coatings, low-solvent coatings, solvent-free coatings, water-based coatings, self-spreading application coatings, impregnating agents etc. are all available. Products are also available which depends upon physical properties for drying.

All the above types of coatings differ greatly from each other in terms of their application requirements and possibilities as well as their chemical and mechanical properties. However, they all have one thing in common: a chemical reaction is almost always needed to produce the required end product. Usually, this reaction must take place at the building/construction site, which is also why many of these products are supplied as multi-component systems.

A great many different colour options are available for finishing layers which are not subject to loss of gloss or discolouration and which are also very durable and scratch-resistant. The degree of roughness can also be adjusted by mixing in wear-resistant minerals etc. or by including anti-slip agents in the (thin) top layer.



10.5 Epoxy (EP)

Epoxy-based mediums are made with epoxy resins and amine curing agents. The standard formulations generally display good properties in terms of toughness, chemical resistant and wear resistance, and they also adhere quite well to most mineral substrates. When used outdoors, loss of gloss sometimes occurs. With regard to reaction/curing times, one should also take into account that a great deal of heat can be generated in the process, leading to shrinkage related problems in thicker layers. Adhesion to other types of substrates is also often amazingly good, which is why these products can be used as both primer and top coating. Some persons are sensitive to certain types of epoxy compounds, leading to a bothersome type of skin irritation. This can often be prevented via a proper choice of binder and the avoidance of specific reactive thinners and solvents. Proper hygiene during application is therefore also very important.

10.6 Polyurethane (PU)

Polyurethanes are made from polyols and isocyanates. Due to the large variety of polyols, curing agents and additives available, the range of possibilities is much greater than with epoxy compounds. Adhesion to various substrates is often excellent. Polyurethane is an excellent option for finishing off concrete floors. Coatings can be realized which combine excellent chemical resistance with colour fastness, weather and wind resistance, wear resistance, and a matt as well as glossy appearance. Reaction times can be modified with the help of various compounds. Problems during application caused by allergic reactions are less frequent than with epoxy compounds, but the instructions with regard to ventilation and hygiene must be strictly complied with for these compounds as well.

Chapter 11: Atmospheric conditions

11.1 Atmospheric conditions

Description: The ability of an environment to cause corrosion
Method: ISO12944-2/NPR 7452

Category	Corrosivity	Indoors	Outdoors
	degree of corrosivity		
C1	very low not very corrosive indoors!	Heated buildings with clean indoor climate: offices, shops, schools, hotels, distribution centres, storage facilities	n/a
C2	low moderately corrosive indoors!	Unheated buildings where condensation can occur, for example in storage facilities, sports facilities etc.	Dry rural areas with little air pollution
C3	moderate not very corrosive outdoors!	Industrial buildings with high levels of humidity and some air pollution: foodstuffs companies, laundries and washing facilities, breweries, dairy firms	Urban and industrial areas with moderate SO ₂ -pollution and coastal areas with low salt concentration
C4	high moderately corrosive outdoors!	Chemical industry, swimming pools and shipyards	Coastal and industrial areas with moderate salt concentration
C5-I	very high, industry industry corrosive outdoors!	n/a	Industrial areas with high levels of humidity and a corrosive atmosphere
C5-M	very high, maritime maritime corrosive outdoors!	n/a	Coastal areas with a high salt concentration and offshore
Im1		Immersion in fresh water	Immersion in fresh water: River installations etc.
Im2		Immersion in salt/brackish water	Immersion in salt water: Sluice doors, bridge elements etc.
Im3		No longer accessible	Immersion in the soil: underground tanks, lighting masts etc.

Chapter 12: Application information

12.1 General

Baril's range of products can be applied with most spraying equipment. In addition, a number of products can also be applied by roller. This chapter provides an overview of the most common spraying equipment, and a brief description is provided below of the working principle behind such equipment. The following application methods are dealt with:

- pneumatic spraying (conventional air spraying);
- airless spraying;
- airmix spraying;
- hot spraying;
- electrostatic spraying;
- two-component spraying;
- HVLP spraying;
- roller and brush.

12.2 Pneumatic/Conventional (air) spraying

This method of applying paint has been used for a long time, and the basic principle is relatively simple. The technical performance of the equipment is still being improved, but the basic concept is the same. Pneumatic spraying, also referred to as air spraying, is based on the injection of paint into a powerful stream of air. The spray pistol, with a top or bottom reservoir, is particularly suited for smaller jobs and/or paintwork involving a great many colour changes. Models with the paint reservoir on the bottom have a greater capacity and allow the operator to work longer without refilling. For larger surfaces, spray pistols are available with a separate pressure-fed reservoir of 2 to 300 litre.

In order to ensure that this spraying technique provides a good result, it is important to first adjust the viscosity of the paint to a suitable level. The amount of paint lost due to overspray with this method is quite large. Most of the products supplied by Baril Coatings can be applied using this method. Every product data sheet includes a guideline for paint viscosity under the header "application information." This spraying method does not make it possible to realize large coating thicknesses in a single process run.

12.3 Airless spraying

Airless spraying was developed to make it possible to cover large areas with thicker paint coatings in a single run. In airless spraying, the paint is converted into a fine spray mist as it is forced through the spray opening under high pressure (150 - 250 bar). Many of the products supplied by Baril Coatings can be applied using this method. Every product data sheet specifies the viscosity to which the paint must be adjusted for airless spraying under the header "application information." Polyurethane paints can be applied via airless spraying, but extra attention must be paid to the layer thickness in that case. If a layer is applied in one run which is too thick, it will result in blistering (trapped air) and foam formation as well as a somewhat matt paint finish, thereby reducing the glossiness of the coating.



12.4 Airmix spraying

Airmix spraying is, in principle, the same as airless spraying. The only difference is that airmix spraying also makes use of compressed air, which is why it is also referred to as air-supporting spraying. In this method, an airless pump applies a pressure of circa 50 bar to the paint. During the application stage, an additional 1 – 1.5 bar of compressed air is added to achieve an improved spray pattern. The application information for this spraying method is also included on the product data sheet. The layer thickness that can be realized in one paint run using this method is less than with airless spraying. This application method is more effective when it comes to obtaining optimum results with the application of polyurethane paints.

12.5 Hot spraying

Hot spraying can be used in combination with airless and airmix spraying. It is particularly useful for very viscous paint products which must be applied so as to achieve a specific layer thickness. In this method, the paint is first heated to 40° to 70° in order to obtain a suitable working viscosity. This makes it unnecessary to thin the paint. The paint is heated in a painting block (hot airless), which is connected to the airless or airmix equipment.

12.6 Electrostatic spraying

The working principle behind this spraying method is that particles with differing electrical charges attract each other. The paint is first converted into a spray mist with the help of pneumatic or airless equipment, after which it is given a negative charge with the help of an electrode and then sprayed onto an object with a positive earth connection. As the paint particles are attracted to the object, they also end up on the back side of the object, substantially reducing paint loss, in particular for jobs done in the open. Some objects with unfavourable/complex shapes only need to be sprayed from one side.

12.7 Two-component spraying

This application method is rapidly gaining ground due to the development of low-solvent and solvent-free products, which are often supplied as two-component systems. The paint itself and the curing agent are delivered in the proper ratio via separate channels and then mixed inside or just before reaching the pistol. Application is done with pneumatic or airless equipment, if necessary with the addition of heat.

12.8 HVLP spraying

HVLP (**H**igh **V**olume **L**ow **P**ressure) spraying has been used for some time by firms specialized in painting and finishing. When an HVLP spray pistol is used, the resulting mist is coarser than with an air pistol. Due to the larger volume of air, the paint particles in the jet of paint are larger, and more paint reaches the object. The HVLP spray method does not provide the same end result as air spraying. But the coarser spray pattern is not noticeable in painting plasterwork. The coarser spray pattern is also not a problem when silky gloss or matt paints are used.

12.9 Roller and brush

Everyone is familiar with the application of paint using a brush. It's a labour-intensive painting method. Working with paint rollers makes it possible to apply layers of paint more quickly. This method is particularly suitable for painting large and flat surfaces. When using a roller, one needs to make sure that the layer of paint applied is thick enough. In order to achieve good results, it is necessary to thin the paint down to a special level, as specified in the product data sheet.

12.10 Possible problems associated with various spraying methods

Every spraying method has its own specific and special instructions for achieving the best results. Nevertheless, the spray pattern and end result may not always be in line with one's

Problem	Cause	Visual effect	Action to take
Tailing	Insufficient pressure or insufficient thinning down	Hard lines in spray pattern	Increase pressure or use smaller nozzle or thin down
Spatter in spray pattern	Trapped air during mixing; new batch of paint	Air bubbles on surface of paint film	Thin down somewhat; remove air from paint by waiting or straining
No flat or vertical spray pattern	Old tip or nozzle; dirt in pistol	Round or angled spray pattern	Replace tip or nozzle; clean pistol
Jerky, jolting	False air inflow, leak in pump	Irregular pattern/width and spray pattern	Check couplings and feed lines
Craters or pinholing	Oil leaking from pump	Craters in the paint film which open up on the surface	Flush and clean out the pump with clean material; avoid contamination
Poor flow pattern	Paint is too thick or sticky and unfavorable viscosity	Appearance is not smooth cellulite appearance	Thin down paint or decrease nozzle diameter and increase pressure
Dripping	Spraying excessively thick layers; maximum pot life reached (above critical point)	Local drips in places where extra-thick layer applied	Thin down paint to enable more even application

expectations..

The overview presented below is intended to help you quickly recognize and solve the most common types of problems and to ensure that you obtain the desired result.

12.11 Amount of paint consumed

In order to correctly calculate the quantity of paint that will be consumed during spray paint application, it is necessary to take a certain level of paint loss into account. The table below provides an overview of the loss percentages associated with various spraying methods. The figures given are intended to serve only as a rough guide.

Application method	Application loss %	Viscosity DIN-cup 4
Pneumatic spraying	30-40	18-35
Airless spraying	20-40	30-60
Airmix spraying	20-40	30-60
Hot spraying	20-40	30-60*
Electrostatic spraying	10-20	18-30
Two-component spraying	20-40	30-60
HVLP spraying	5-10	20-35
Roller and brush	4-6	80-120

*This viscosity is realized by increasing the temperature of the paint.

In some cases, the application loss can be much higher, for example when spray painting openwork objects (e.g. balcony fencing).

All the information needed to obtain good application results are included on the product data sheet. The information is intended to serve only as a guideline. During paint application processes, various factors play an important role including: temperature, humidity, working conditions, nozzle diameter and angle.



Chapter 13: Paint

13.1 Why paint?

Without paint or similar products, we would have to live in an environment filled with rusting iron, rotting wood, and eroded concrete and with the consequences of all this deterioration. We would also miss out on a great deal of colour and colour options, which make life a lot more pleasant and enjoyable.

Paint has three main functions:

- protection
- decoration
- hygiene

13.2 Definition of paint

Paint is a liquid, paste or powder product applied in thin or thicker layers on a substrate, which is then converted during the drying process into a solid film. In the first place, paint is intended to protect the substrate and must therefore meet special requirements. Over the past 20 years, the focus has also increasingly come to lie on decoration and colouring (aesthetic aspects).

Paint consists of four major components, and each component helps determine the performance characteristics of the paint:

- binders
- pigments and fillers
- solvents and thinners
- additives

13.3 Binders

Binders serve to bind the pigments and fillers in the paint layer and to provide them with good adhesion to the substrate. The type of binder determines to a large extent the various performance characteristics of the paint.

13.4 Pigments and fillers

These are the filler materials which give paint its colour, strength and covering power. The pigments also convert damaging shortwave UV radiation into longer wavelengths that are less damaging. This helps slow down and prevent the degradation and aging of the paint product by UV radiation.

13.5 Solvents and thinners

The function of these ingredients is to make the paint more workable and easier to apply. Paint is actually a product composed primarily of solid ingredients, some of which have been converted into liquids by the addition of solvent. The solvent therefore functions as a transport agent but does not in itself alter the characteristics of the paint film. Once the paint has been applied, the solvent will disappear into the air via evaporation. Of course, solvents are not present in solvent-free paint products, which are available in liquid as well as powder form. The most important types of solvent/thinners are:

- aliphatic hydrocarbons such as turpentine, naphtha etc.
- aromatic hydrocarbons such as xylene
- alcohols such as ethanol, propanol, butanol etc.
- esters such as ethyl acetate, butyl acetate etc.
- ketones such as acetone, methyl ethyl ketone etc.
- glycol ethers such as ethyl glycol, butyl glycol etc.
- glycol esters such as ethyl glycol acetate etc.

13.6 Additives

These compounds fulfil various functions and therefore sometimes help determine the desired characteristics of the paint:

- *Siccatives* which cause drying of oxidative binders (alkyds) and include calcium, cobalt, zirconium, etc.
- *Surface active agents* which provide smoothness to the surface
- *Anti-skinning agents* which prevent paint from forming a skin inside the packaging
- *Plasticizers* which provide elasticity to the paint film
- *Anti-settling agents* which prevent heavy filler materials from settling during storage
- *Wetting agents* which ensure that the pigments are more easily dispersed throughout the paint
- *De-aerating agents* which ensure that the air that is mixed into the paint during production and application is released from the paint film in a timely fashion after application and before drying
- *Anti-flooding agents* which prevent the flotation of pigments to the surface after application
- *Levelling agents* which promote an optimal flow after application and secure high quality finishing
- *Fungicides* which ensure that no microorganisms can survive in the wet paint medium (e.g. water-based wall paint) and/or ensure that no algal growth can take place on the paint film surface (e.g. for anti-fouling coatings on ships)



13.7 Drying

The paint drying process can take place in various ways and depends upon the type of binder used in the paint. The following types of drying process can be distinguished:

- physical drying
- semi-physical drying
- chemical drying
- oxidative drying
- two-component paints
- catalytically mediated drying

13.7.1 Physical drying

This drying process is caused by the evaporation of the solvent from the paint film, causing the film to become increasingly dry and hard. After a paint film has dried out, it can easily be dissolved again using the original solvent present.

Examples of paints formulated in this fashion:

- Nitrocellulose paints (in varnishes for the paper and furniture industry)
- Chlorinated rubber paints (for ships and steel structures)
- Polyvinyl (for concrete and steel structures)
- Bitumen or bituminous paints (for offshore and steel structures)

13.7.2 Semi-physical drying

This is characteristic for water-based acrylics, also known as "dispersion paints." In these dispersions, the binder particles are finely dispersed in water. After application of the paint, the water will first start to evaporate. As evaporation progresses, the binder particles flow together and are compressed to form a microscopically tight paint film.

Examples of such paints include water-based acrylic paints, which are used for protecting and covering concrete, steel, wood and plasterwork.

13.7.3 Chemical drying

This type of drying occurs because, during and after the evaporation of any solvent present, a chemical reaction takes place. The following types of chemical drying can be distinguished:

- oxidative drying
- two-component drying
- catalytically mediated drying

13.7.4 Oxidative drying

Alkyd paints: Alkyd-based paints are some of the most popular paints in the steel coatings market as well as the professional painting sector and do it yourself hobby market. This is due to their good application properties, fast drying, and relatively low price. Alkyd paints dry by absorbing oxygen from the air. The higher the percentage of oil in the paint, the slower the drying process is.

There are three types of alkyd paints, each with its own typical market segment:

- Short oil alkyd: this type contains the lowest percentage of oil, up to circa 40%. This makes it the fastest drying type, and it is used primarily for industrial applications such as steel coatings;
- Medium oil alkyd: the percentage of oil in this type varies between ca. 40% and 60%. It dries relatively quickly and displays good outdoor durability and performance. The largest markets for this group are the steel coatings sector and the professional painting sector;
- Long oil alkyd: the percentage of oil in this type is more than 60%. The drying speed is therefore fairly standard. The largest markets for this group are the professional painting sector and the do it yourself hobby sector. In the steel coatings sector, it is often applied as a repair coating by brush in the form of a conventional as well as High Solid product;
- Baking finishes: the drying process for some of these types can be accelerated by heating the object.

13.7.5 Two-component paints

In these paints, the film formation process is based on a chemical reaction between the curing agent and the primary component. the base component. these products is created by a chemical reaction of the curing agent with the base component. During this reaction, the chemical chains in the wet paint film become tougher and harder. At the end of the chemical reaction the paint film reaches its final hardness. The chemical reaction starts as soon as both components are mixed together.

The two components are separately packed and supplied and need to be thorough mixed just before application of the paint.

These paints include:

- Epoxy paints:
These paints are very popular for providing protective coatings for steel, in particular wherever good adhesion, mechanical durability, and chemical resistance are desired. These epoxy coatings are often available in the following types: Primers, zinc-rich primers, sealers, intermediate coatings (with or without miox), coatings and finishes.
- Polyurethane paints:
These paints have the same positive characteristics as the epoxy coatings, but loss of gloss in the finish over longer periods of time is not an issue with polyurethane paints. The curing process for these paints is also less temperature sensitive than for epoxy paints.
Additional advantages include: excellent mechanical strength, toughness and wear resistance; excellent chemical resistance; reasonably heat resistant; good adhesion after proper surface preparation; good performance; good gloss retention; good long-term colour-fastness and retention.

13.7.6 Drying via catalytic mediation

These coating types are also provided as two-component systems, but here the curing agent is replaced by a catalyst. This catalyst functions as an initiator or "starter." When it is mixed together with the primary component, a strong molecular network is established consisting of the binder (polyvinyl butyral), the pigment (zinc-tetra oxychromate) and the available acid (phosphoric acid) in the catalyst. These primers are supplied in only a few colours and are applied in relatively thin coating thicknesses.

The surface to be coated may be cold- or hot-rolled steel as long as grease and oil have been effectively removed beforehand. Aluminium and other metals are also suitable substrates, as this type of primer also etches itself into the metal surface, thereby ensuring excellent adhesion. These primers are often also referred to as "wash primers" and are sometimes supplied already pre-mixed.

13.8 Corrosion protection methods

There are three ways to slow down the process of corrosion:

- Passive corrosion control (sealing)
- Active corrosion control (via anti-corrosion pigments)
- Cathodic protection

13.8.1 Passive corrosion control

This method is very popular in the "heavy duty" industry. The working principle involved is sealing off the substrate from compounds that cause corrosion such as oxygen, moisture and other chemicals present in the environment. The level of protection is determined by the film thickness applied and the selected coating system. The most popular systems are high solids epoxy and polyurethane coatings, with or without iron oxides, aluminium and micaceous iron oxides.

13.8.2 Active corrosion control

The addition of anti-corrosive pigments to the paint (e.g. zinc phosphate) creates an active anti-corrosive product. The protection is based on the fact that the zinc sacrifices itself for the steel substrate by corroding first. This method is still one of the most popular methods in the protective steel coatings sector, as protection can already be achieved at very thin coating thicknesses. In addition, this method can be applied in practically all qualities and types of coatings.

13.8.3 Cathodic protection

The working principle behind this method is that application of an electrical potential prevents corrosion of the steel substrate.

Cathodic protection can be implemented in two ways:

- Passive: by attaching sacrificing anodes (e.g. zinc) in a fixed fashion to the steel substrate. These anodes will then corrode instead of the steel substrate. This method is used for large constructions and ships.
- Active: by applying a current to the construction (Impressed Current Cathodic Protection), thereby lowering the electric potential of the steel. This method is used for large bridges or similar traffic structures and underground steel pipes.

Chapter 14: Working with paint

14.1 Paint storage

Paint must be stored under appropriate conditions that satisfy specific requirements in order to ensure that the quality of the paint is maintained and to prevent fires.

The storage space must be sufficiently dry, ventilated and protected from sunlight and from sparks and unenclosed fire. Direct sunlight can raise the temperature in the paint can and cause the paint to settle out. During cold weather conditions, the space must be heated to ensure that the paint is kept at the appropriate application temperature. Water-based paints are sensitive to frost, and if they become frozen will become unusable.

14.2 Paint viscosity

The desired paint viscosity also depends upon the application method chosen. Obviously, a different viscosity is required in the case of brush application than with a spray-based application.

Various options are available for adjusting or influencing the viscosity:

- adjusting the temperature of the paint
- thinning the paint
- using thixotropic paints

From the perspective of maintaining the quality and performance characteristics of a paint product, it is better to ensure that the paint has the proper application temperature than to thin the paint with solvent.

For example, if the paint is too viscous at a temperature of 8°C, then the viscosity can be lowered by raising the temperature to about 18-20°C, which means that less thinning will be required!

If thinning still remains necessary, then we strongly recommend that you follow the thinning instructions given by the paint supplier which apply specifically to the paint products concerned. If thinners other than the recommended ones are used, the polarities of the solvent and binder may differ too much, therefore requiring more thinner than would otherwise be necessary and modifying the technical characteristics of the paint.

It goes without saying that in the case of two-component products, the viscosity of the product after mixing is more important than the separate viscosities of the primer or curing agent.

Once the colour of the mixed product has become stable and even, you can be sure that both products have been thoroughly mixed, and only then is it possible to evaluate the viscosity of the mixed product.

The so-called thixotropic paints or coatings are quite common in the protective coatings sector for steel. If these paints are stirred inside the can with a spatula, they initially appear to be very viscous and fall off the spatula in blobs. However, the harder one stirs or mixes it, the less viscous the paint becomes. This is because of the energy being transferred to the paint. If the mixing is stopped and the paint is allowed to rest, it will regain its original viscosity. This same thing happens if the paint is applied via spray painting. As soon as the paint is fed into the pump and becomes 'energized' it becomes less viscous.



As the paint is forced through the small nozzle opening of the pistol, it is converted into a fine spray or mist. The result is an optimum distribution of paint on the object being sprayed.

Once the paint reaches the substrate and is no longer in motion, the viscosity increases, thereby allowing the paint to 'stay where it is.'

The great advantage of this method is that it makes it possible to apply a thicker layer at one go, as the paint quickly becomes viscous enough to remain stuck on the surface.

14.3 Pot life

Pot life is the length of time that a catalyzed resin system retains a viscosity low enough to be used in processing. Pot life is measured by determining the length of time required for the viscosity of a paint product, after mixing, to double via the chemical reaction. By thinning the paint, it is possible to influence the pot life. The temperature also plays an important role in determining pot life. As two-component coatings depend upon chemical reactions, an increase in temperature will reduce pot life, whereas a decrease in temperature will often extend it.

For some years now, products have been available with good curing characteristics even at lower temperatures. As a result, the drying characteristics are still good even at temperatures as low as 0-5°C, without this having any influence on pot life.

14.4 Mixing

Proper mixing is essential for obtaining a product that can be used effectively and that complies with its performance and other technical specifications.

Mixing a ready-to-use single-component product is quite different from mixing a two-component product.

In the case of a single-component product, one has only to mix the product in the pot until it is homogeneous and, if necessary, thin it down, after which the paint is immediately ready for application.

In the case of a two-component product, the primary component and the curing agent must first be mixed together to obtain a single homogeneous product which is evenly distributed throughout the container and has a homogeneous and even colour.

Paints sometimes settle out somewhat inside the pot and this can lead to the formation of clots or thicker pieces. It is then advisable to continue mixing for some time until any such pieces are not only well distributed throughout the paint but have also become dissolved should that be necessary.

We recommend using a clean mixing tool to ensure that no foreign paint or colour is transferred from one pot to the other.

If mixing is carried out smoothly but at a high enough rotational speed to generate an effective vortex, the amount of air trapped inside the liquid will be minimal and a smoother spray painting pattern will result. Here also, the temperature is important: it is easier to mix a paint at a temperature of 18-20°C than at 5°C.



14.5 Recognizing different coating systems

Alkyd paint systems become harder as they age until they end up becoming brittle. A fast-drying alkyd paint will become harder more quickly and become more brittle than one which has normal drying characteristics. This is also why outdoor durability, flexibility and gloss retention of alkyd paints with normal drying characteristics are generally better. For some colours and types of gloss finish, loss of gloss may occur over time. Alkyd coatings and/or varnishes are not very resistant to strong solvent such as xylene or thinners.

Chlorinated rubber paint systems tend to become somewhat less brittle than alkyd paints as they age. However, chlorinated rubber paints tend to lose their gloss and become yellowish over time.

These paints dissolve readily in aromatic solvents such as xylene and thinners.

Epoxy paint systems harden well and adhere well to various surfaces. Over time, especially when used outdoors, some of the gloss will disappear and yellowing takes place. Whether or not this effect is visible or noticeable depends also on the specific colour chosen.

These paints have good resistance to solvents, and their resistance to chemicals depends upon the quality of the paint.

Polyurethane paint systems display great hardness and good outdoor durability as well as colour fastness and good gloss retention over time.

Resistance to solvents and chemicals is good.

Water-based acrylic paint systems can have flexible as well as hard surfaces. Gloss retention is good, and yellowing hardly ever occurs.

Resistance to solvents is moderate to good.

Of course, every type of coating is also available in various qualities, in which case some properties will be better and some will be less good.



Chapter 15: Types of paint

15.1 General

One of the most effective ways of protecting metals against the influence of climate is the application of a coating or paint system. Various types of paint can be used to realize this. In order to make an appropriate choice from the various types of paint available, it is necessary to have some insight into the characteristics of the various paint types. A great many different types of paint are available, and only the most important types will be described here. The various paints will be classified according to the type of binder used, as the binding agent largely determines the characteristics of the paint.

15.2 Alkyd paint

This group of paints is often referred to synthetic paint or alkyd paint. They are one of the most popular types, and hardening of the paint film is the result of oxygen absorption. Alkyd paints are used practically everywhere, as they are extremely versatile. They are used in the house painting sector, construction sector and for ship coatings.

Generally speaking, alkyd paints have the following characteristics:

- durable
- good flow characteristics
- fast drying
- good gloss retention
- good elasticity
- reasonably good corrosion control

15.3 Baking finish

This group consists of paints which are heated to accelerate the curing or hardening process. Most baking finishes consist of a melamine resin together with an alkyd resin or polyester. These products are very suitable for use in industrial mass production processes. Generally speaking, they are hard and wear-resistant.

The combination of alkyd resin and melamine resin produces the following characteristics:

- scratch-resistant
- durable
- good hardness
- water-resistant
- good chemical resistance



15.4 Acrylic paint

A solution of an acrylic resin is very suitable for serving as a binder whereby the drying process is a physical one. Evaporation of the solvent simply leaves a paint film behind. An important advantage of these so-called thermoplastic acrylic resins is that they dry quickly at room temperature. As a result, these products are suitable for applications in which a fast drying process is desired but raising the temperature is not possible. These products are also used for car repair paints and concrete paints.

15.5 Chlorinated rubber paint

Chlorinated rubber paints are used whenever resistance to chemicals is important. These paints are very popular in the shipbuilding sector, for above-water and underwater components, power pylons and bridges.

Chlorinated rubber paints have the following characteristics:

- water-resistant
- resistant to chemicals
- easy to apply
- single-component
- elastic paint film

15.6 Vinyl paint

Vinyl paints also have good chemical resistance. Their drying properties depend upon evaporation, and they are suitable for use in single-layer systems.

Vinyl paints have the following characteristics:

- wear-resistant
- water-resistant
- good adhesion on metal surfaces
- good chemical resistance

One specific type of vinyl paint is a product made on the basis of polyvinylbutyral. This type of paints shows excellent adhesion to many different kinds of surfaces and is therefore also used in formulating glues. They are also well known for their use in so-called washprimers.



15.7 Two-component epoxy paints

Two-component paints are products which must be mixed together with a curing agent just before use. After mixing, the paint is usable for a short period of time i.e. the so-called pot life. Epoxy paints can react with various types of curing agents. The type of curing agent used will affect the final characteristics of the epoxy paint coating. Generally speaking, these paints provide coatings with excellent characteristics. Epoxy paints have the following characteristics:

- hardness
- good adhesion on metals
- very good chemical resistance
- very good water resistance

A disadvantage of epoxy paints for outdoor applications is that, over time, part of the outer layer turns into powder, thereby losing its glossy finish. One cause of this is that the polymer is broken down by sunlight over time. As a result, epoxy paints are most suited for use in base primers and in finish coatings in combination with micaceous iron oxide.

15.8 Polyurethane paint

Polyurethane paints are mostly two-component products, whereby the primary component is mixed together with a curing agent shortly before use. There are two important types of polyurethane paints, the aliphatic and aromatic polyurethane paints. The most important difference between these two types is that the aromatic type is subject to yellowing over time whereas the aliphatic type is not. Besides the two-component versions, there are also single-component polyurethane paints, the so-called moisture-curing polyurethane paints which use moisture for the curing or hardening process.

There are many possibilities for formulating polyurethane paints, which is why there are many types on the market, which can also differ markedly in characteristics.

Some important characteristics of these paints are:

- hardness and wear-resistance
- resistance to water and chemicals
- excellent overall adhesion
- fast drying

Chapter 16: Overview of definitions

16.1 Thinning

The paint is supplied at the manufacturer's viscosity for application via spray painting, including airless spray painting, as well as for application by roller and brush. If requested, the paint can also be supplied at a specific viscosity. If the paint is too viscous (thick), for example in case of cold weather, then a small quantity of thinner may be added to obtain the required viscosity. The recommended amount of thinner to be added is specified by the manufacturer for various application methods. Excessive thinning can negatively affect the results. Addition of a small quantity of thinner will not significantly affect the dry paint film. However, if too much thinner is added, the user should realize that addition of thinner lowers the concentration of solids in the paint. As a result, it will be necessary to apply a thicker wet paint layer to achieve the same desired dry film thickness.

16.2 Mixing ratio

Two-component products are supplied in the form of an A component (primary) and a B component (curing agent), packaged in the correct mixing ratio. It is important to always use this same ratio, even if not all of the product is used. Start by mixing component A until a homogeneous mass is obtained. Then add component B and mix until a homogeneous mixture has been obtained. Make sure you completely remove all of component B from its container, if necessary with the help of a small amount of thinner, to ensure that the correct mixing ratio is obtained. The curing reaction starts as soon as both components are mixed together, and the mixed product remains usable for a limited period of time, the so-called pot life. Do not mix more product together than you can effectively utilize within the pot life of the product.

16.3 Induction time

The induction time is the recommended waiting time between the mixing of both components and the start of the application process, in order to allow the curing reaction to get underway. It applies only to certain types of two-component epoxy products, as specified on the product data sheets.

16.4 Theoretical coverage

The theoretical coverage is defined as the number of square metres (m²) which can be covered by one litre of paint. The wet film thickness used for calculating the coverage is the film thickness realized in practice with the help of the most commonly used application method. Based on the volume percentage of solids, it is then possible to calculate the dry film thickness. The theoretical coverage, expressed in m²/l, is then calculated as follows:

$$\text{Theoretical coverage in m}^2/\text{l} = \frac{\text{volume percentage of solids}}{\text{dry film thickness in micrometres}} \times 10$$

Some illustrative figures are presented in the table below:

Theoretical coverage in m²/l

Dry film thickness in μ	Volume percentage of solids							
	20	25	30	35	40	45	50	
25	8.0	10.0	12.0	14.0	16.0	18.0	20.0	
30	6.7	8.3	10.0	11.7	13.3	15.0	16.7	
50	4.0	5.0	6.0	7.0	8.0	9.0	10.0	
60	3.3	4.2	5.0	5.8	6.7	7.5	8.3	
80	2.5	3.1	3.8	4.4	5.0	5.6	6.2	
100	2.0	2.5	3.0	3.5	4.0	4.5	5.0	
125	1.6	2.0	2.4	2.8	3.2	3.6	4.0	
150	1.3	1.7	2.0	2.3	2.7	3.0	3.3	

Volume percentage of solids	Dry film thickness in μ									
	70	100	125	150	200	300	400	500	1000	
60	8.6	6.0	4.8	4.0	3.0	2.0	1.5	1.2	0.6	
65	9.3	6.5	5.2	4.3	3.3	2.2	1.6	1.3	0.7	
70	10.0	7.0	5.6	4.7	3.5	2.3	1.8	1.4	0.7	
75	10.7	7.5	6.0	5.0	3.8	2.5	1.9	1.5	0.8	
80	11.4	8.0	6.4	5.3	4.0	2.7	2.0	1.6	0.8	
85	12.1	8.5	6.8	5.7	4.3	2.8	2.1	1.7	0.9	
90	12.9	9.0	7.2	6.0	4.5	3.0	2.3	1.8	0.9	
95	13.6	9.5	7.6	6.3	4.8	3.2	2.4	1.9	1.0	
100	14.3	10.0	8.0	6.7	5.0	3.3	2.5	2.0	1.0	

If, as is the case for spray painting, extra thinner is added to the paint, then the volume percentage of solids in the ready to use paint mixture will decrease. The volume percentage of solids in the thinned down paint is then equal to:

$$\frac{\text{volume of paint before thinning (l)} \times \text{volume percentage of solids in paint before thinning}}{\text{volume of paint before thinning (l)} + \text{volume of thinner added (l)}}$$

16.5 Practical coverage

In actual practice, the following factors affect the practical coverage:

- surface profile/roughness
- absorption by substrate
- application loss

The loss depends upon a great many factors including: skill and experience of paint applicator, application method, size and shape of object, nature of substrate, film thickness applied, and conditions during application. It is therefore not possible to specify a generally applicable value for the practical coverage. We do not recommend spreading the paint layer out as much as possible. It is better to ensure that the desired film thickness is actually realized.

16.5.1 Calculations

The practical coverage is calculated by multiplying the theoretical coverage by a factor which depends upon the surface profile, the application method and the application conditions (see table below). The values specified in this table should be viewed as a rough guideline, as the working procedure also has a great influence on the practical coverage.

Substrate	20-80 micrometre			50-200 micrometre		
	Roller, spray or brush	Indoors	Outdoors	Roller, spray or brush	Indoors	Outdoors
Smooth closed surface	0.85	0.75	0.70	0.90	0.80	0.70
Smooth steel (cold-rolled)	0.85	0.75	0.70	0.90	0.80	0.65
Blasted steel (fine blasting)	0.80	0.70	0.65	0.85	0.75	0.70
Blasted steel (rough blasting)	0.75	0.65	0.60	0.80	0.70	0.60
Raw concrete and stone	0.60	0.55	0.50	0.70	0.65	0.50



16.6 Recommended film thickness per layer

This is the thickness of the dry or wet paint film used as a basis for the information in the product data sheets. Depending upon the desired degree of chemical or mechanical resistance, other film thicknesses may be recommended.

16.7 Drying time

16.7.1 Dust-free

Drying rates are specified in terms of the time required for the paint film to become dust-free and tack-free respectively. These times are temperature dependent and specified for 20°C. Enclosed areas need to have sufficient ventilation to remove the evaporating solvents in order to achieve acceptable drying times. Solvent evaporation is one of the factors affecting drying of the paint film. For two-component paints which require curing and for paints which depend upon oxidative drying, the drying process also depends upon a chemical reaction. This chemical process for paints is called curing. The speed of this process depends upon the temperature: faster at higher temperatures and slower at lower temperatures.

16.7.2 Curing time

For two-component paints, curing times are specified based on an average ambient temperature of 20°C. As a rule of thumb, an increase in temperature of 10°C reduces the curing time by half.

16.7.3 Recoatability time

This is the required drying time between the application of successive layers of paint. As is the case for the other drying times mentioned above, this also depends upon temperature. For some products, this time interval is also limited to a maximum value, as adhesion between the successive layers may diminish with time. If the maximum interval is exceeded, it may be necessary to roughen up the surface to ensure effective adhesion of the following layer. Some products are also available for which the drying time between paint layers is not that critical. However, primer coatings should not be left exposed for too long in aggressive environments. The drying time specified between paint layers applies to successive layers of similar products. For different types of products, different times may apply. A freshly painted surface that has been exposed to a contaminated environment must always be thoroughly cleaned before a subsequent layer is applied.

16.8 Flashpoint

The flashpoint is the lowest temperature of a product at which just enough vapour exists in the air to enable it to be ignited in the air. The flashpoint is determined with the help of the Abel-Pensky closed cup method. The values specified are rough estimates and can serve as a guideline within the framework of local safety regulations with regard to fire/explosion hazard during transport, storage and processing. If significant changes occur in the composition of the product, relevant to the flashpoint, an updated product data sheet will be issued. Addition of thinner can significantly alter the flashpoint of a paint.



16.9 Density

The density is the mass (weight) of the paint in kilograms per litre at 20°C. For two-component products, the density is specified for the mixed product, unless specified otherwise. The density may vary somewhat with colour. The values specified are averages.

16.10 Solids

The percentage of solids per weight or per volume is specified under 'volume of solids.' It is calculated on the basis of the paint formulation and gives the relationship between the wet film and dry film thickness:

$$\begin{aligned} \text{Dry film thickness} &= \text{wet film thickness} \times \text{volume percentage of solids} \\ \text{Wet film thickness} &= \frac{\text{dry film thickness}}{\text{volume \% of solids}} \times 100 \end{aligned}$$

The volume percentage of solids can vary somewhat, and the values specified are average values.

16.11 Heat resistance

Heat resistance is specified in terms of the maximum temperature to which the coating can be continuously exposed without suffering damage. Yellowing and/or discolouration may occur. Some rough general guidelines are given below.

Type of binder used in the coating	Maximum temperature
Bitumen/chlorinated rubber/vinyl coatings	70 °C
Alkyd coatings	120 °C
Epoxy-tar coatings	120 °C
Polyurethane coatings	120 °C
Epoxy coating	150 °C
Alkyd aluminium	175 °C
Epoxy aluminium	200 °C

Very heat-resistant paints (450°-500° Celsius) often have special binders such as silicones or silicates.

16.12 Application conditions

This generally refers to:

- ambient temperature (i.e. surrounding temperature)
- surface to be painted and selected paint
- relative humidity

If the surface to be painted is wet or moist, it may also impact the paintwork. A term which is often used, correctly or incorrectly, is the dew point. What exactly is the dew point, and what does it have to do with paintwork or protective coatings?

To understand this, we must first explain what is meant by the term relative humidity (RH). All air contains water vapour (moisture), which is invisible. Warm air can hold more water vapour than cold air. The maximum concentration of water vapour (saturation value) in air at various temperatures is specified in the table below.

Temperature °C	Maximum concentration of water vapour in g/m ³
0	4.8
5	6.8
10	9.5
15	12.8
20	17.3
25	23.0
30	30.4
35	39.6
40	51.1
45	65.0

Usually, the air around us contains less water vapour than its maximum saturation value, in which case the relative humidity is less than 100%. Relative humidity is defined as:

RH = the quantity of water vapour (moisture) contained by air at a specific temperature divided by the maximum quantity of water vapour which the air can contain at the same temperature. To convert this value to a percentage, it is multiplied by 100.

Example:

Ambient air temperature = 20°C. The air contains 12 g of water vapour per m³. What is the RH?

At 20°C, air can contain a maximum of 17.3 g per m³ of water vapour. RH is therefore:

$$\frac{12}{17.3} \times 100 = 69\%$$

16.12.1 Dew point

If we introduce a cold object, for example a glass of water with ice cubes, into air that contains water vapour, then the water vapour contained in the air may condense onto the object, as the air coming in contact with the object will cool down and therefore be able to hold less water vapour. We usually notice this in the winter when moisture condenses upon cold windows. The surface temperature at which water vapour will just start to condense on an object is called the dew point. The larger the value is for the RH of the air, the smaller the difference will be between the dew point and the ambient temperature. The relationship between air temperature, RH and the dew point is illustrated in the following table.

Temp °C	Relative Humidity					
	Gram	50% Dew point in °C	Gram	60% Dew point in °C	Gram	70% Dew point in °C
1	2.5		3.0		3.5	
2	2.7		3.2		3.7	
3	2.9		3.4		4.0	
4	3.1		3.7		4.3	
5	3.3		3.9		4.6	0.0
6	3.5		4.3		5.0	1.0
7	3.8		4.6	0.0	5.3	2.0
8	4.1		4.9	1.0	5.7	3.0
9	4.4		5.2	1.8	6.1	4.1
10	4.7	0.2	5.6	2.7	6.5	4.9
11	5.0	1.0	6.0	3.7	7.0	5.8
12	5.3	2.0	6.4	4.6	7.5	6.8
13	5.7	3.0	6.9	5.8	8.0	7.8
14	6.1	4.1	7.3	6.6	8.5	8.7
15	6.5	4.9	7.8	7.5	9.1	9.7
16	7.0	5.9	8.4	8.5	9.7	10.7
17	7.4	6.8	8.9	9.4	10.4	11.6
18	7.9	7.8	9.5	10.3	11.1	12.6
19	8.5	8.8	10.1	11.2	11.8	13.5
20	9.0	9.7	10.8	12.1	12.6	14.5
21	9.6	10.6	11.5	13.1	13.4	15.4
22	10.2	11.4	12.3	14.2	14.2	16.4
23	10.9	12.2	13.0	15.0	15.2	17.5
24	11.6	13.2	13.9	16.0	16.2	18.4

Explanation: Gram = grams of water per m³ dry air at the specified air temperature in °C
Dew point is the temperature to which the air in question would have to be cooled to achieve a relative humidity of 100%.

Temp °C	Relative humidity					
	Gram	80% Dew point in °C	Gram	90% Dew point in °C	Gram	100% Dew point in °C
1	4.0		4.5	0.0	5.0	1.0
2	4.3		4.8	0.5	5.3	2.0
3	4.6	0.0	5.2	1.5	5.7	3.0
4	4.9	1.0	5.5	2.5	6.2	4.0
5	5.3	1.9	5.9	3.5	6.6	5.0
6	5.7	2.8	6.4	4.4	7.1	6.0
7	6.1	3.8	6.8	5.5	7.6	7.0
8	6.5	4.8	7.3	6.4	8.1	8.0
9	7.0	5.8	7.8	7.4	8.7	9.0
10	7.5	6.7	8.4	8.4	9.3	10.0
11	8.0	7.6	9.0	9.4	10.0	11.0
12	8.6	8.6	9.6	10.4	10.7	12.0
13	9.1	9.5	10.3	11.4	11.4	13.0
14	10.0	10.6	11.0	12.3	12.2	14.0
15	10.4	11.4	11.7	13.3	13.0	15.0
16	11.1	12.5	12.5	14.4	14.0	16.0
17	11.9	13.5	13.4	15.4	14.9	17.0
18	12.7	14.5	14.3	16.3	15.8	18.0
19	13.5	15.6	15.2	17.3	16.9	19.0
20	14.2	16.6	16.2	18.3	18.0	20.0
21	15.3	17.5	17.3	19.3	19.2	21.0
22	16.3	18.5	18.4	20.2	20.4	22.0
23	17.4	19.5	19.6	21.2	21.7	23.0
24	18.5	20.4	21.0	22.2	23.1	24.0

Explanation: Gram = grams of water per m³ dry air at the specified air temperature in °C
 Dew point is the temperature to which the air in question would have to be cooled to achieve a relative humidity of 100%.

The tables above can be used to read off the dew point value for the most common combinations of temperature and relative humidity. Only the moisture-curing polyurethane paints, such as the Poluran MC products, may be applied on a moist surface. Other solvent-containing paints must be applied to a dry surface, the temperature of which must be at least 3°C above the dew point to allow for the fact that evaporation of the solvent causes the surface to cool down. One should also take into account that moisture may penetrate into the wet paint film after painting has been completed. It is therefore risky to engage in painting activities late in the afternoon if the skies are clear and the relative humidity is high. To be on the safe side, the surface temperature of the object being painted should be at least 3°C above the dew point. At a relative humidity of 85%, the lowest acceptable object surface temperature is equal to the ambient (surrounding air) temperature.

For the above reasons, outdoor painting work may be carried out only if the relative humidity does not exceed 85%. At a relative humidity of 90%, the difference between the temperature of the steel object and the dew point is only 2°C, which means that the margin of safety between the dew point and the ambient air temperature is very small. It can be increased by raising the temperature of the steel by 1°C. At a relative humidity of 70%, the relationship between an acceptable surface temperature and the ambient air temperature is presented in the table below:

	Relative Humidity 70%			
Air temperature °C	5.0	10.0	20.0	30.0
Dew point °C	0.0	4.7	14.4	23.9
Lowest acceptable surface temperature °C	3.0	7.7	17.4	26.9

In spite of the fact that the temperature of the steel surface in the above table is clearly lower than the ambient air temperature, no condensation will occur under these conditions. If the lowest acceptable temperature is 5°C and the ambient air temperature is the same, then the air could be warmed up, in which case the relative humidity would decrease as illustrated below:

	5.0	10.0	20.0	30.0	40.0
Temperature °C	5.0	10.0	20.0	30.0	40.0
Relative humidity %	85	60	32	18	11

16.12.2 Attention

In enclosed spaces, sufficient ventilation must be applied to remove solvent vapours. Ventilation to provide fresh air during application of the paint and during the drying process is then required from the viewpoint of health and safety and also to ensure adequate evaporation of the solvent from the paint film.

16.13 Application at construction site or workshop?

Application at construction site or workshop?

In order to realize maximum lifespan and optimum performance for the paint system concerned, we recommend that most layers of the paint system and, if possible, the entire paint system be applied in the workshop. For aesthetic reasons, a decision may be taken to apply the finish layer at the construction site after assembly.

The advantages and disadvantages of applying the entire paint system in the workshop are as follows;

Advantages	Disadvantages
The application process can be better managed/controlled	Limited possibilities if the object is very large
Controlled temperature	Risk of damage during transport and assembly
Controlled relative humidity	Risk of exceeding maximum overcoat time
Cheaper	
Easier to make adjustments/repairs	
Better monitoring of surface contamination	

The decision whether to apply the finish coating at the construction site therefore depends largely on the type of object/construction concerned and whether there is much risk of significant mechanical damage during assembly. Another important aspect is whether the object will be exposed to the elements for a long period of time before protection becomes available in the form of a roof. If that is the case, then we recommend applying the finish layer at the construction site.

16.14 Film thickness

The dry film thickness of a single paint layer applied to a surface.

Method: ISO2808:1991(E)
Classification: not applicable

Nominal film thickness

Description:

The recommended dry film thickness per layer, or for the entire paint system, which is required to achieve the desired durability.

The effective average dry film thickness per layer, calculated on the basis of 10 measurements per component, may not be less than 80% of the nominal film thickness. A maximum of 10% of the measurements may have a value between 80% and 100% of the nominal film thickness if the overall average value is equal to or larger than the nominal film thickness.

Extremely high film thicknesses should be avoided. Information on maximum film thickness per product is provided in the product data sheets. We recommend calibrating the film thickness measuring equipment on the same surface as the one that will later be coated.

16.15 Gloss

Gloss is the visual impression created by the light-reflecting properties of a surface and depends upon the incidence of light and observation.

Method: ISO2813-1978(E), measurement angle: 60°

Classification:

Classification:	Gloss %
Mat	0-10%
Eggshell	10-20%
Silky gloss	20-45%
Semigloss	45-75%
Full gloss	75-100%

16.16 Blasting profile

This is the profile of peaks and valleys produced by blast cleaning the surface.

Method: ISO2632, Rugotest, Ra-value

Classification:

The Rz value is also often used. This is defined as the difference between the highest peak and the deepest valley of the blasting profile as determined over 5 measurement areas.

We recommend blast cleaning the surface in such a manner as to ensure that the value of Rz does not exceed 70 µm.

If the priming coats will be exposed to a contaminated atmosphere for a longer period of time, we recommend that Rz not exceed 50 µm.


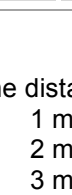
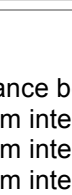
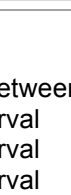
The roughness of the surface profile influences the variation in the film thickness of the paint system, and this should be taken into account when applying the paint. In case of a high average film thickness, a normal roughness profile (Rz = 50 µm) will not affect the durability. However, for priming coats, the variation in film thickness caused by a high Rz value can lead to early rust formation, in particular on 'peaks' which are not well coated.

16.17 Adhesion (determination)

The checkerboard incision test: adhesion is determined with the help of a ruler and a Stanley knife with a straight knife edge. A pattern of lines is cut into the surface whereby 6 parallel lines are first cut, followed by a second set of 6 parallel lines perpendicular to the first set. Tape with the required characteristics (adhesive strength 10N, 25 mm wide) is then lightly pressed onto the surface. Finally, the tape is pulled away from the surface in one smooth motion at an angle of 60°.

The extent to which the paint squares in between the lines are pulled off the surface is a measure of the adhesion.

Baril Coatings recommends the use of Sellotape type 1112 or 1401 or Scotch tape 828.
Method: ISO2409:1992(E)

Classification	Class	Loss of adhesion	Illustration
-very good	Gt0	0%	-
-good	Gt1	< 5%	
-mediocre	Gt2	5 - 15%	
-poor	Gt3	15 - 35%	
-very poor	Gt4	35 - 65%	
-total loss of adhesion	Gt5	65 - 100%	-

Depending upon the film thickness, the distance between the lines is as follows;

0-60 micron dry film thickness	1 mm interval
60-120 micron dry film thickness	2 mm interval
120-250 micron dry film thickness	3 mm interval
>250 micron	St Andrew's cross cut test or Elcometer test (ISO-4624)

If the paint coating may be subjected to mechanical forces, the adhesion of the paint system should be class GT0/GT1 or better. If no mechanical loading factors are present, it should be GT2 or better

16.18 Anti-Graffiti

Graffiti goes back a long way and has been a contemporary art form throughout history. In the present day, graffiti is also used to permanently or temporarily 'decorate' less attractive surroundings.

However, every form of undesired graffiti is perceived by owners and residents as a form of vandalism. It is a form of damage which can usually be repaired but which nevertheless entails significant costs. As it is practically impossible to prevent its occurrence, objects must, where necessary, be protected against irreparable damage from undesired graffiti. No single product or system has yet been developed which works for every type of surface and/or type of graffiti. As a result, various products and systems have been developed. In choosing a system, a great many factors should be taken into account, including:

- which protective systems are possible/applicable
- what will the consequences be in terms of the requirements demanded of the surface
- what surface preparation is required
- what will visibility, durability and maintenance be
- what will the environmental impact be (including the cleaning process for the system) and last but not least the total price

Anti-Graffiti Systems are basically nothing more or less than 'barrier coatings' which protect the surface from sustainable penetration and/or adhesion by the graffiti and therefore facilitate cleaning without damaging the surface itself.

The many different anti-graffiti systems can be classified on the basis of the behaviour of the system relative to the cleaning agents and/or methods.

- **Permanent systems:**
These systems are not damaged or dissolved by the cleaning agents used when the graffiti is removed.
- **Self-sacrificing systems:**
These systems are themselves completely removed when the graffiti is removed. Immediately after the graffiti is removed, the system must be applied anew.
- **Semi-permanent systems:**
These systems are often a combination of a permanent priming coat and a self-sacrificing top coating. But this group also includes single-layer systems on the basis of a single product which becomes partly dissolved upon removal of the graffiti, and which therefore must also be reapplied after the cleaning process.

In cases where large works of graffiti must be removed, one can first use a high-pressure steam cleaner in combination with an industrial cleaning agent such as Enviclean 4951. For graffiti which is more difficult to remove, white spirit can be used with or without the addition of water. Stubborn areas can be treated with undiluted white spirit by hand or with the help of a rotary cleaning lance. This will cause the finish layer to lose some of its gloss, but this effect will be only temporary.

Finally, one should realize that an anti-graffiti system always consists of a 'barrier coating' together with the relevant cleaning agents. Protective systems and/or combinations of cleaning agents other than the ones recommended may cause damage to the surface system and may therefore not be applied.

16.19 Low-solvent paint

The term low VOS (volatile organic solvents) is often used to indicate that the paint has been formulated with as little solvent as possible.

Low VOS paints should therefore contain a substantially lower concentration of solvent than their traditional competitors in the same area of application.

A low VOS paint is not by definition a high-solids paint.

16.20 Solvent concentration

The concentration of solvents in the paint product is expressed in gram/litre.

16.21 High-solids

A paint product is described as a high-solids paint if the concentration of solvent does not exceed 250 gram per litre. In actual practice, for the coatings commonly used, this is equivalent to a volume percentage of solids equal to at least 70%.

A high-solids paint is therefore also a low VOS product.

A medium-solids paint has a solvent concentration of between 250 and 450 gram/litre.

If the solvent concentration exceeds 450 gram per litre, then the paint is described as solvent-rich.

16.22 ISO 12944 part 1 to 8 (incl.)

Protection of steel constructions against corrosion with the help of paint systems

ISO 12944: deals with the protection of steel constructions with the help of paint systems and includes all factors which are important for realizing adequate protection against corrosion

ISO 12944-1: in addition to a general statement regarding health, safety and environmental protection, this section describes several basic concepts and definitions used in relation to the protection of steel.

ISO 12944-2: this section describes the environmental factors and conditions which encourage corrosion, including a detailed description of the atmospheric categories.

It describes the corrosion factors to be expected in situations where steel constructions are surrounded by water or are located underground.

These corrosion factors are important to take into account when selecting a suitable corrosion protection system.

This section is important for the principal /architect.

ISO 12944-3: this section provides information on design criteria for steel constructions with the aim of improving their resistance to corrosion.

This section is important for the architect/design engineer.

ISO 12944-4: this section describes the various types of surfaces/substrates to be protected. It also describes the various types of preliminary treatment methods..

This section is particularly important for the painting contractor.

ISO 12944-5: this section describes the various types of protective systems, arranged according to atmospheric load, which have proved suitable for controlling corrosion on constructions.

The examples of paint systems given here are representative of the current global knowledge available in this area.

This section is of particular importance to the supplier of paint products, the principal, and consulting firms.

ISO 12944-6: this section describes accelerated test methods which can be used to determine the durability of paint systems. These test methods can be of assistance in particular for paint systems regarding which insufficient practical experience is available and for encouraging their application. With the help of these test methods, new products can be introduced and applied more quickly.

The indoors B.A.S. low VOS paint systems in particular are the subject of these accelerated tests.

This section is important for all parties involved in providing recommendations for protection.

ISO 12944-7: this section describes the working procedure for applying the coating in the workshop or at the construction site. It deals with the methods for applying and storing coatings, inspection, maintenance advice, and the use of reference sections.

This section is of particular importance for the painting contractor, general contractor and the inspection/certification body.

ISO 12944-8: this section describes the management of projects dealing with the protection of steel constructions against corrosion. Various types of specifications are distinguished such as: project specifications, paint system specifications, paint application specifications, inspection specifications, and test specifications.

Project management activities are simplified and standardized with the help of model forms for planning, reference sections and inspection activities.

This section is important for all parties involved.

16.23 Shelf life

Shelf life is the minimum period of time for which the product can be stored without being opened at temperatures between 15°C and 30°C.

Generally speaking, the product can actually be stored for a considerably longer period of time than the minimum time specified.

16.24 Coverage and cost per m²

Guidelines for calculating the amount of paint used and the cost of paint per m²

It is all too easy to categorize paint as simply being expensive or inexpensive on the basis of the price per litre or, even more questionably, the price per kg. What really counts is the price per square metre of painted surface.

16.25 Theory and practice

The determining factor for the coverage realized with a paint, in other words the surface that can be painted with one litre, is the wet film thickness to be applied. After the solvent has evaporated, the thinner and dry paint film remains behind.

The difference between the wet and dry film thickness is determined by the volume percentage of solids in the paint. In practice, the question asked is often: how many m² can be painted per litre assuming a particular dry film thickness in micrometres? The table below specifies the coverage as a function of the volume percentage of solids and the dry film thickness. The formula used here is:

$$\frac{\text{volume percentage of solids}}{\text{dry film thickness in } \mu} \times 10 = \text{theoretical coverage in m}^2/\text{l}$$

Dry film thickness in μ	Volume percentage of solids						
	20	25	30	35	40	45	50
25	8.0	10.0	12.0	14.0	16.0	18.0	20.0
30	6.7	8.3	10.0	11.7	13.3	15.0	16.7
50	4.0	5.0	6.0	7.0	8.0	9.0	10.0
60	3.3	4.2	5.0	5.8	6.7	7.5	8.3
80	2.5	3.1	3.8	4.4	5.0	5.6	6.2
100	2.0	2.5	3.0	3.5	4.0	4.5	5.0
125	1.6	2.0	2.4	2.8	3.2	3.6	4.0
150	1.3	1.7	2.0	2.3	2.7	3.0	3.3

To calculate the practical coverage actually realized, the theoretical coverage has to be corrected for paint lost during the painting process. This can vary quite a lot depending upon various factors such as the application method, type of object, surface, professional skill etc. As a rule of thumb, one may assume that between 5% and 10% is lost in the case of roller/brush application. The paint loss in the case of spray painting can vary between 20% and 80%.

Quantity of paint required and cost of materials per m²

The quantity of paint required for a paint job can now be calculated with the help of the following formula:

$$L = \frac{S}{\frac{VS}{dft/10}} \times \frac{1}{1 \times 100} L$$

Where:

- L = quantity of paint in litres
- S = surface in square metres
- dft = dry film thickness in micrometres
- VS = volume percentage of solids in the paint
- L = estimated loss percentage

In addition, the cost of the paint per square metre can now be calculated by dividing the cost of the paint per litre by the coverage. This can be illustrated by an example from the table above in which the film thickness is 50 microns and the volume percentage of solids is 40%. If the price of the paint is € 11.35 per litre and the loss percentage is 10%, then the cost of materials per m² becomes:

A) 25:8 + 10% = € 0.70.

Compare this with a paint that costs only € 9.53 but has a volume percentage of solids equal to 20%:

B) 21:4 + 10% = € 2.62.

Although paint B costs € 1.81 less per litre, the user will end up paying much more per square metre of surface actually painted.