

Marine & Offshore Division
Marine Website: <http://www.veristar.com>
Email: veristarinfo@bureauveritas.com

Guidelines for Corrosion Protection Applicable to Inland Navigation Vessels

October 2013

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Inland Navigation Management
Mechelsesteenweg 128/136
B-2018 Antwerpen - Belgium
Tel: + 32 (0)3 247 94 00 / + 32 (0)3 247 94 70
Email: bvnirulesbelgium@be.bureauveritas.com
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MARINE & OFFSHORE DIVISION

GENERAL CONDITIONS

ARTICLE 1

1.1. - BUREAU VERITAS is a Society the purpose of whose Marine & Offshore Division (the "Society") is the classification ("Classification") of any ship or vessel or offshore unit or structure of any type or part of it or system therein collectively hereinafter referred to as a "Unit" whether linked to shore, river bed or sea bed or not, whether operated or located at sea or in inland waters or partly on land, including submarines, hovercrafts, drilling rigs, offshore installations of any type and of any purpose, their related and ancillary equipment, subsea or not, such as well head and pipelines, mooring legs and mooring points or otherwise as decided by the Society.

The Society:

- "prepares and publishes Rules for classification, Guidance Notes and other documents ("Rules");
- "issues Certificates, Attestations and Reports following its interventions ("Certificates");
- "publishes Registers.

1.2. - The Society also participates in the application of National and International Regulations or Standards, in particular by delegation from different Governments. Those activities are hereafter collectively referred to as "Certification".

1.3. - The Society can also provide services related to Classification and Certification such as ship and company safety management certification; ship and port security certification, training activities; all activities and duties incidental thereto such as documentation on any supporting means, software, instrumentation, measurements, tests and trials on board.

1.4. - The interventions mentioned in 1.1., 1.2. and 1.3. are referred to as "Services". The party and/or its representative requesting the services is hereinafter referred to as the "Client". The Services are prepared and carried out on the assumption that the Clients are aware of the International Maritime and/or Offshore Industry (the "Industry") practices.

1.5. - The Society is neither and may not be considered as an Underwriter, Broker in ship's sale or chartering, Expert in Unit's valuation, Consulting Engineer, Controller, Naval Architect, Manufacturer, Ship-builder, Repair yard, Charterer or Shipowner who are not relieved of any of their expressed or implied obligations by the interventions of the Society.

ARTICLE 2

2.1. - Classification is the appraisalment given by the Society for its Client, at a certain date, following surveys by its Surveyors along the lines specified in Articles 3 and 4 hereafter on the level of compliance of a Unit to its Rules or part of them. This appraisalment is represented by a class entered on the Certificates and periodically transcribed in the Society's Register.

2.2. - Certification is carried out by the Society along the same lines as set out in Articles 3 and 4 hereafter and with reference to the applicable National and International Regulations or Standards.

2.3. - It is incumbent upon the Client to maintain the condition of the Unit after surveys, to present the Unit for surveys and to inform the Society without delay of circumstances which may affect the given appraisalment or cause to modify its scope.

2.4. - The Client is to give to the Society all access and information necessary for the safe and efficient performance of the requested Services. The Client is the sole responsible for the conditions of presentation of the Unit for tests, trials and surveys and the conditions under which tests and trials are carried out.

ARTICLE 3

3.1. - The Rules, procedures and instructions of the Society take into account at the date of their preparation the state of currently available and proven technical knowledge of the Industry. They are a collection of minimum requirements but not a standard or a code of construction neither a guide for maintenance, a safety handbook or a guide of professional practices, all of which are assumed to be known in detail and carefully followed at all times by the Client.

Committees consisting of personalities from the Industry contribute to the development of those documents.

3.2. - The Society only is qualified to apply its Rules and to interpret them. Any reference to them has no effect unless it involves the Society's intervention.

3.3. - The Services of the Society are carried out by professional Surveyors according to the applicable Rules and to the Code of Ethics of the Society. Surveyors have authority to decide locally on matters related to classification and certification of the Units, unless the Rules provide otherwise.

3.4. - The operations of the Society in providing its Services are exclusively conducted by way of random inspections and do not in any circumstances involve monitoring or exhaustive verification.

ARTICLE 4

4.1. - The Society, acting by reference to its Rules:

- "reviews the construction arrangements of the Units as shown on the documents presented by the Client;
- "conducts surveys at the place of their construction;
- "classes Units and enters their class in its Register;
- "surveys periodically the Units in service to note that the requirements for the maintenance of class are met.

The Client is to inform the Society without delay of circumstances which may cause the date or the extent of the surveys to be changed.

ARTICLE 5

5.1. - The Society acts as a provider of services. This cannot be construed as an obligation bearing on the Society to obtain a result or as a warranty.

5.2. - The certificates issued by the Society pursuant to 5.1. here above are a statement on the level of compliance of the Unit to its Rules or to the documents of reference for the Services provided for. In particular, the Society does not engage in any work relating to the design, building, production or repair checks, neither in the operation of the Units or in their trade, neither in any advisory services, and cannot be held liable on those accounts. Its certificates cannot be construed as an implied or express warranty of safety, fitness for the purpose, seaworthiness of the Unit or of its value for sale, insurance or chartering.

5.3. - The Society does not declare the acceptance or commissioning of a Unit, nor of its construction in conformity with its design, that being the exclusive responsibility of its owner or builder.

5.4. - The Services of the Society cannot create any obligation bearing on the Society or constitute any warranty of proper operation, beyond any representation set forth in the Rules, of any Unit, equipment or machinery, computer software of any sort or other comparable concepts that has been subject to any survey by the Society.

ARTICLE 6

6.1. - The Society accepts no responsibility for the use of information related to its Services which was not provided for the purpose by the Society or with its assistance.

6.2. - If the Services of the Society or their omission cause to the Client a damage which is proved to be the direct and reasonably foreseeable consequence of an error or omission of the Society, its liability towards the Client is limited to ten times the amount of fee paid for the Service having caused the damage, provided however that this limit shall be subject to a minimum of eight thousand (8,000) Euro, and to a maximum which is the greater of eight hundred thousand (800,000) Euro and one and a half times the above mentioned fee. These limits apply regardless of fault including breach of contract, breach of warranty, tort, strict liability, breach of statute, etc.

The Society bears no liability for indirect or consequential loss whether arising naturally or not as a consequence of the Services or their omission such as loss of revenue, loss of profit, loss of production, loss relative to other contracts and indemnities for termination of other agreements.

6.3. - All claims are to be presented to the Society in writing within three months of the date when the Services were supplied or (if later) the date when the events which are relied on were first known to the Client, and any claim which is not so presented shall be deemed waived and absolutely barred. Time is to be interrupted thereafter with the same periodicity.

ARTICLE 7

7.1. - Requests for Services are to be in writing.

7.2. - Either the Client or the Society can terminate as of right the requested Services after giving the other party thirty days' written notice, for convenience, and without prejudice to the provisions in Article 8 hereunder.

7.3. - The class granted to the concerned Units and the previously issued certificates remain valid until the date of effect of the notice issued according to 7.2. here above subject to compliance with 2.3. here above and Article 8 hereunder.

7.4. - The contract for classification and/or certification of a Unit cannot be transferred neither assigned.

ARTICLE 8

8.1. - The Services of the Society, whether completed or not, involve, for the part carried out, the payment of fee upon receipt of the invoice and the reimbursement of the expenses incurred.

8.2. - Overdue amounts are increased as of right by interest in accordance with the applicable legislation.

8.3. - The class of a Unit may be suspended in the event of non-payment of fee after a first unfruitful notification to pay.

ARTICLE 9

9.1. - The documents and data provided to or prepared by the Society for its Services, and the information available to the Society, are treated as confidential. However:

- "Clients have access to the data they have provided to the Society and, during the period of classification of the Unit for them, to the classification file consisting of survey reports and certificates which have been prepared at any time by the Society for the classification of the Unit;
- "copy of the documents made available for the classification of the Unit and of available survey reports can be handed over to another Classification Society, where appropriate, in case of the Unit's transfer of class;
- "the data relative to the evolution of the Register, to the class suspension and to the survey status of the Units, as well as general technical information related to hull and equipment damages, may be passed on to IACS (International Association of Classification Societies) according to the association working rules;
- "the certificates, documents and information relative to the Units classed with the Society may be reviewed during certifying bodies audits and are disclosed upon order of the concerned governmental or inter-governmental authorities or of a Court having jurisdiction.

The documents and data are subject to a file management plan.

ARTICLE 10

10.1. - Any delay or shortcoming in the performance of its Services by the Society arising from an event not reasonably foreseeable by or beyond the control of the Society shall be deemed not to be a breach of contract.

ARTICLE 11

11.1. - In case of diverging opinions during surveys between the Client and the Society's surveyor, the Society may designate another of its surveyors at the request of the Client.

11.2. - Disagreements of a technical nature between the Client and the Society can be submitted by the Society to the advice of its Marine Advisory Committee.

ARTICLE 12

12.1. - Disputes over the Services carried out by delegation of Governments are assessed within the framework of the applicable agreements with the States, international Conventions and national rules.

12.2. - Disputes arising out of the payment of the Society's invoices by the Client are submitted to the Court of Nanterre, France, or to another Court as deemed fit by the Society.

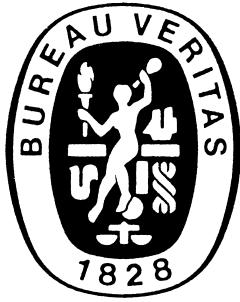
12.3. - Other disputes over the present General Conditions or over the Services of the Society are exclusively submitted to arbitration, by three arbitrators, in London according to the Arbitration Act 1996 or any statutory modification or re-enactment thereof. The contract between the Society and the Client shall be governed by English law.

ARTICLE 13

13.1. - These General Conditions constitute the sole contractual obligations binding together the Society and the Client, to the exclusion of all other representation, statements, terms, conditions whether express or implied. They may be varied in writing by mutual agreement. They are not varied by any purchase order or other document of the Client serving similar purpose.

13.2. - The invalidity of one or more stipulations of the present General Conditions does not affect the validity of the remaining provisions.

13.3. - The definitions herein take precedence over any definitions serving the same purpose which may appear in other documents issued by the Society.



GUIDANCE NOTE NI 607

NI 607

Guidelines for Corrosion Protection Applicable to Inland Navigation Vessels

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SECTION 1 GENERAL

1 General

1.1 Introduction

1.1.1 Corrosion is one of the main causes of structural problems encountered on vessels in service. Large areas of vessel structures can be subject to severe corrosion:

- water ballast tanks
- bulk carrier holds, especially when carrying cargoes of corrosive nature, e.g. coal with high sulphur content
- cargo tanks, following washing operations.

1.1.2 Many factors contribute to the spread of corrosion, including:

- severe stress on certain zones
- water retained on horizontal surfaces
- condensation and streaming of water
- corrosive cargoes
- inadequate cleaning of bulker holds.

Some of these factors can be taken into account at the design stage, by examining the behaviour of the structure in relation to corrosion. However, such measures are not sufficient to prevent or reduce the effects of corrosion. The durability of a structure subject to corrosion depends mainly on corrosion protection applied to the new building.

1.2 Scope

1.2.1 These guidelines are intended to provide Owners, building yards and the Society's Surveyors with information and recommendations aiming to fulfilling the requirements for hull structure preservation laid down in NR217, Pt B, Ch 8, Sec 2. In particular, they will enable all the above-mentioned parties to:

- make a proper choice and draw up specifications of the corrosion protection system
- assure a proper maintenance of the corrosion protection system
- carry out efficiently inspections required for the corrosion protection system within the scope of surveys for class assignment and maintenance.

SECTION 2 CORROSION OF STEEL

1 General

1.1 Definition

1.1.1 Corrosion is the degradation of metallic materials and their properties due to interaction with their environment. It is difficult to totally eliminate corrosion as most materials used for engineering applications, including steel and aluminium, are thermodynamically unstable, compared to the naturally occurring oxides and hydroxides.

1.2 Electrochemical nature of corrosion

1.2.1 Nearly all corrosion reactions in the marine environment are electrochemical in nature, i.e., electrical current is associated with the chemical reactions of corrosion. The driving force of corrosion can be considered the electrical potential difference between two states of matter. In most marine corrosion processes, electrical current passes between two sites (an anode and a cathode) through an electrolyte (water), with associated reactions at both the anode and cathode. The reaction at the anode is the corrosion reaction, called oxidation.

1.2.2 There are several requirements for electrochemical corrosion to take place:

- there must be an anode and cathode
- both must be in contact with a common electrolyte
- there must be an electrical connection between the anode and cathode, other than the electrolyte
- there must be a thermodynamic tendency for electrochemical reaction to occur.

Eliminate any one of these elements, and corrosion will not occur.

2 Unprotected steel

2.1 Types of corrosion

2.1.1 Galvanic corrosion

This type of corrosion occurs when two metals or alloys are electrically in contact in a corrosive environment (electrolyte). The less noble metal, in other words the one with the greater electronegative potential, is attacked (anode). The most noble metal is protected (cathode). A more detailed explanation of the processes involved is given in App 1.

This type of corrosion is affected by the following factors:

- difference in potential between the two metals or alloys
- relative surface areas of anodic and cathodic zones
- distance between anode and cathode
- electrical resistance of the galvanic circuit (which depends, in particular, of the electrolyte conductivity and of the coating protection).

2.1.2 General corrosion

This involves an almost uniform attack over the surface of the material. In this type of corrosion, the galvanic process extends uniformly over the whole surface.

This form of corrosion is not particularly dangerous, because it can be predicted by tests, and wear on the material is proportional to time and easily measurable.

2.1.3 Pitting corrosion

This involves a localised attack, which can result in perforation of the metal or alloy. It is one of the most insidious forms of corrosion.

This form frequently occurs on damaged parts of non-conducting layers on the surface of the metal (oxide film). In particular, pitting often occurs on stainless steels, and is usually caused by surface contamination.

2.1.4 Crevice corrosion

This is an intense localised form of corrosion, usually associated with small volumes of stagnant solution resulting from holes, masked surfaces or crevices.

The mechanism can be explained by the fact that the stagnant solution inside the crevice prevents the diffusion and migration of ions, and that access of oxygen to the metal surface area at corrosion bottom is inadequate to keep the protective oxide layer intact (case of stainless steels).

2.1.5 Stress corrosion

In this type of corrosion, fractures occur in the material exposed to a corrosive environment and subject to stresses, the levels of which would not be regarded as dangerous if they were applied outside the corrosive environment. For example, these stresses can be the residual stresses of welding or thermal stresses. Such fractures are also not easily detectable.

2.1.6 Bacterial corrosion

This form of corrosion is termed Microbiologically Influenced Corrosion (MIC) caused by certain bacteria, particularly sulphate-reducing anaerobic bacteria.

Such corrosion develops under corrosion deposit product, or in deaerated raw water circuits.

2.2 Main corrosion factors

2.2.1 Electrolyte salinity

Level of salinity gives the measurement of conductivity of the water. This encourages galvanic corrosion and localised attacks. Seawater contains high level of salinity (about 3,5%) compared to brackish water (1-2,5%) and fresh water (below 1%)

In addition, chlorides present in seawater produce breakings in the protective oxide films responsible for corrosion resistance of many materials.

Finally, as regards general corrosion, the rate of corrosion increases in proportion to the salt content.

2.2.2 Oxygen

Oxygen is one of the most important factors in corrosion. A decrease in oxygen concentration causes a rise in corrosion rates. In addition, variations in oxygen concentration on the surface of the same material result in corrosion by differential aeration: surfaces with the lowest oxygen concentration undergo accelerated corrosion.

2.2.3 Electrolyte temperature

In general, and if there is no modification in environment, corrosion increases with temperature. in the same way, it increases with the speed of circulation.

2.2.4 Bacteria

Bacteria present in water can cause local changes in corrosive conditions, and are therefore dangerous for most metallic materials. The mechanisms of bacterial attack are still unknown. However, efforts are made to combat it by trying to limit the deposits beneath which such bacteria develop, and by using bactericides.

Bacteria known to cause MIC are listed in Tab 1 together with environment conditions and metallic materials affected.

Table 1 : Bacteria known to cause MIC

Genus of Species	pH	Temperature range °C	Oxygen Requirement	Metals Affected
Desulfovibrio	4 - 8	10 - 40	Anaerobic	Iron, steel, stainless steels, aluminium, zinc and copper alloys
Desulfotomaculum	6 - 8	10 - 40 (Some 45 - 75)	Anaerobic	Iron and steel, stainless steels
Desulfomonas		10 - 40	Anaerobic	Iron and steel
Thiobacillus thiooxidans	0,5 - 8	10 - 40	Aerobic	Iron and steel, copper alloys
Thiobacillus ferrooxidans	1 - 7	10 - 40	Aerobic	Iron and steel
Gallionella	7 - 10	20 - 40	Aerobic	Iron and steel
Sphaerotilus	7 - 10	20 - 40	Aerobic	Iron and steel

Table 2 : Corrosion rates, in mm/year, for seagoing oil tankers

Plating	Segregated ballast tank	Cargo / ballast tank	Cargo oil tank
Deck	0,10 - 0,50	0,05 - 0,30	0,03 - 0,10
Side shell	0,05 - 0,10	0,05 - 0,10	-
Bottom	0,05 - 0,25	0,05 - 0,25	0,04 - 0,10
Longitudinal bulkhead	0,10 - 0,30	0,03 - 0,50	0,03 - 0,10
Transverse bulkhead	0,30 - 0,50	0,02 - 0,10	0,03 - 0,10

2.3 Corrosion rates

2.3.1 For information, Tab 1 gives some corrosion rates, in mm/year, on structures of seagoing oil tankers in service. These figures refer to uncoated platings.

3 Steel protected by paint coating

3.1 General

3.1.1 In the case of surfaces protected by coats of paint, corrosion can develop in one of the ways described in [3.1.2] to [3.1.4].

3.1.2 Local cracks in the paint film

In this case, corrosion is galvanic, and highly active.

These local cracks in the surface can result from mechanical wear or defects in the paint film which have not been checked and repaired on the new building stage (e.g. absence of grinding to smooth the sharp edges of cutouts).

Such cracks may also result from localised fatigue stresses, caused by design errors, or from plastic structural deformations exceeding the elongation properties of the paint film.

3.1.3 Lack of thickness of paint film

A dry film of paint is never completely impermeable to liquid and gas, and full protection requires a certain thickness in order to provide a proper barrier against corrosion.

This type of corrosion is slower than in the case of a local crack in the paint film, but it is generally more extensive.

3.1.4 Premature ageing of paint film

Premature ageing of the paint film, particularly of the top coat, will mean less protection for lower layers, and consequently greater permeability to liquid and gas. For this purpose, the film should have a homogeneous thickness in any point.

Premature ageing of the top coat may result from the incorrect choice of type of paint for its resistance to chemicals, UV or heat, for example.

SECTION 3 CORROSION PROTECTIONS

1 Corrosion control methodologies

1.1 General

1.1.1 Methods for controlling corrosion are grouped into five categories according to [1.2] to [1.6].

1.2 Material selection

1.2.1 Material selection is choosing a material for the specific environment and application so that the resultant corrosion, if any, is maintained within acceptable limits.

1.3 Design

1.3.1 Designing for corrosion control addresses factors that can lead to corrosion such as eliminating crevices, eliminating standing water, allowing for drainage, and also includes providing allowances for corrosion.

1.4 Coatings

1.4.1 Coatings act by physically separating the metal from the effects of environment (electrolyte) thus removing an essential factor for corrosion. There is type of coating which acts only as a barrier. Barrier coatings include greases and oils, as well as common organic coatings (paints).

1.5 Cathodic protection

1.5.1 General

Cathodic protection is an electrical technique recommended to be used together with coatings for corrosion protection of immersed components and structures, such as underwater hulls, external propulsion gear, and ballast tanks.

1.5.2 Sacrificial anode cathodic protection

Sacrificial anode cathodic protection is a natural method using a more active metal to protect the vessel's structure or component. The more active metal is placed in electrical contact and in the same electrolyte with the metal to be protected. The active metal becomes the anode of the electrochemical cell and corrodes, the site of the oxidation reaction, while the structure to be protected becomes the cathode. This natural form of cathodic protection is called sacrificial anode cathodic protection since the active metal sacrifices to protect the structure. The active, sacrificial metal may be provided in the form of a sacrificial anode, or may be incorporated into the chemistry of coating such as in zinc rich coatings.

1.5.3 Impressed current cathodic protection

In the impressed current cathodic protection, the active metal is replaced by a direct current power source that serves to make the structure the cathode.

1.6 Inhibitors

1.6.1 Inhibitors are substances that, when added in small quantities to the environment, inhibit one or more of the steps in the corrosion process. Inhibitors are commonly used in three ways:

- in closed loop fluid systems, such as boiler steam systems, where the concentration of inhibitor in the liquid can be maintained
- in the form of vapor phase inhibitors to reduce atmospheric corrosion in closed spaces
- in coatings.

2 Coatings

2.1 General

2.1.1 A coating is any material that will form a continuous film over a surface; whereas paint refers to a general type of coating in which a mixture of pigment and vehicle together form a liquid or paste that can be applied to a surface, and is organic in nature. Coating is broad category that includes paints (organic coatings), as well as inorganic metallic and non-metallic coatings.

2.1.2 Paint system

A good protection system by painting depends on the following parameters:

- choice of types of paint, which is to be suitable for the surface to be protected, the environment and required useful life
- surface preparation, which is to be suitable for the paint
- thickness of the film
- conditions of application
- work planning
- conditions of survey and inspection.

Moreover, it should be remembered that paint manufacturer's recommendations must be respected under all circumstances.

2.1.3 Types of paints

In the following, drying is the evaporation of the solvent, whereas curing is the ultimate reaction of the components. Curing may be by:

- atmospheric drying
- baking (temperature activated), or
- catalyst activated chemical reaction.

Organic coatings (paints) are most commonly categorised by binder type, cure mechanism or a combination of the two.

Organic coatings include asphalt, oil, alkyd, acrylic, vinyl, epoxy and urethane. Special purpose coatings include anti-fouling coatings and zinc-rich coatings. Non-organic coatings include inorganic non-metallic coatings, metal coatings and conversion coatings.

a) Asphalts

Asphalts are derived from petroleum and coal residues and include natural asphalts and coals tars. Asphalts may be used alone or mixed with other materials. These coatings are typically inexpensive, heavy, and do not require extensive surface preparation. They degrade in sunlight and may not dry hard.

b) Oils

Oils are based on naturally occurring oils such as linseed, tung, pine and fish oils and provide a stable film when oxygen from the air reacts with oil molecules to harden the film and produce limited cross-linking.

c) Alkyds

Alkyd resin (also called polyester) offers great versatility. Alkyds have good color stability and are suitable for use in most atmospheric and mildly industrial environments, but should not be used in strongly acidic or alkali conditions.

d) Acrylics

There are two major categories of use for the acrylic resin. First, acrylic resins are used in conjunction with other resins, for example, epoxies and vynils, to improve appearance in exterior applications, and second, acrylics are used in the preparation of latex water based paints. Latex paints are used extensively for interior applications where appearance considerations are equal to or exceed durability requirements.

e) Vinyl

Vinyl coatings are based on the same molecule as common PVC (poly-vinyl-chloride) piping and are extremely resistant to most organic substances such as acids, alkalis, oils and alcohols as well as water.

f) Epoxy

Although the epoxy resin may be combined with oils, epoxy coatings are most often two-component coatings, in which two liquids (generally called the base and the hardener, an oil fatty acid) are mixed and chemically react to form the epoxy ester, which is an extremely cross-linked film. The extensive cross-linking results in some of the most desirable coating properties. Epoxies must, however, be mixed and applied properly, and are somewhat sensitive to the surface preparation and cleanliness of the substrate.

g) Urethane

Urethanes are also formed by the reaction between a base (isocyanate) and a hardener (a hydroxyl compound). Although often used for a variety of exterior and immersed applications, the properties of urethane coatings, as a class, can be varied more widely than almost any other organic coating.

h) Anti-fouling

Anti-fouling paint is a classification by special property. Anti-fouling paints are designed to prevent the attachment and growth of biological matter on structures and hulls.

i) Zinc-rich coatings (inorganic non-metallic)

Inorganic non-metallic zinc coatings utilize zinc in the coating structure. These coatings are most often used as primers, either stand-alone or in conjunction with topcoats and provide cathodic protection to the substrate.

j) Metallic coatings

Metallic coatings provide a metallic layer over the substrate. The metal coating may be anodic (active) or cathodic (noble) to the substrate. In anodic metal coatings, the coating metal is less corrosion resistant (anodic) than the substrate and provides sacrificial cathodic protection, whereas in cathodic metal coatings (such as nickel plating), the coating is more corrosion resistant (cathodic) than the substrate.

k) Conversion coatings

These coatings convert the surface of the substrate to provide the desired affect. Processes include anodizing, phosphating, and the most common, chromating.

2.2 Hard coatings

2.2.1 Definition

Generally, hard coating is a paint. This is in liquid form prior to application and dries after application. A dry, hard coat of paint then remains on the surface, hence the term "hard coating".

2.2.2 Paint components

The main components of paints are the following:

- the binder (resin) is responsible for providing adhesion, binding the pigment, and also gives the paint resistance properties which make the final coating tough and durable
- the pigments play a large role in determining color and appearance. Some pigments also provide added bulk, helping to thicken a paint when needed
- the fillers increase the bulk of the coating, improve density and can improve abrasion resistance
- the additives, when certain properties need to be manipulated or enhanced, additives are often the solution. Thickeners, for example, are additives that help thicken the paint to make application easier
- the solvent is responsible for transporting the binder and other components to the substrate surface. The type of solvent depends upon the other components of the given paint. Oil-based paints, for example, can use a basic paint thinner as the solvent. Latex-based paints, on the other hand, tend to use water as their solvent.

2.2.3 Criteria for the selection of paint systems

In order to select the paints for a particular application, it is important to know their main properties and the particular conditions for their application and maintenance specified herebelow:

a) Surface preparation

The quality of the necessary surface preparation varies in degree. Requirements shall be respected in order to ensure that the paint adheres properly to the material. This factor has a fairly high impact on the total application cost.

b) Two-component and one-component paint

There are obviously risks of mixing two-component paints incorrectly, or using the wrong proportions.

c) Percentage solvents

A paint containing a high percentage of solvent will be easy to apply, but solvent evaporation will be more intense, and precautions are needed to ensure replacement of air. Solvent free paints should preferably be used in confined spaces for safety reasons.

d) Temperature of application

Temperature limits should be respected in order to ensure satisfactory application and drying. This applies especially to chemical curing paints, as epoxy.

e) Recoating time

These are the minimum and maximum times between which a second coat of paint may be applied, to retain maximum adherence between the two coats.

f) Drying time

This is an important factor, particularly in case of repairs for which the available time is often short.

g) Colour

In order to check that one coat will cover the coat below, colour of paints can be alternated.

h) Maximum dry film thickness

When the paint film is thin, several coats can be needed to ensure the required protection. This implies a significant increase in the application cost.

i) Covering properties

Certain very hard paints, or paints which have a very smooth, high gloss finish, present poor adhesion qualities. It is advisable to use such paints only for the top coat.

j) Elongation

This property is to be taken into account when the paint is applied to a zone subject to stresses and/or to fatigue.

k) Resistance to water and chemicals

This parameter is to be considered in relation to the environment in contact with the painted surface.

l) Resistance to abrasion, impacts, heat and UV

These properties should be examined in relation to the surrounding environment.

m) Toxicity

For health and safety reasons, the painter must be informed of any dangers he may incur.

Table 1 : Characteristics of cleaning methods

Method	Characteristics
Blastcleaning ("Sa")	Excellent to remove metal oxides, scales and substances adhering to the surface
	Excellent to ensure surface roughness
	May be insufficient to remove grease, oil and water-soluble salts
	Work time much shorter than for other methods
Mechanical or manual cleaning ("St"): • Scraper • Buffer • Brush	Insufficient to ensure surface roughness: risk of polishing the surface
	Insufficient to remove grease, oil and water-soluble salts
	Costly methods