NIPPON PAINT MARINE

ONBOARD MAINTENANCE SOLUTIONS GUIDE

Recognised in Japan as Basic & New 日本ペイントマリン株式会社

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These chapters will help guide you through Onboard Maintenance of paint on ships.

Chapter 1

Introduction to Onboard Maintenance

1.1

Maintain quality and condition of ship's appearance

Reduce time and cost needed during dry-docking

Retain value of ship assets

Minimise corrosion and rust to prolong vessel service lifespan

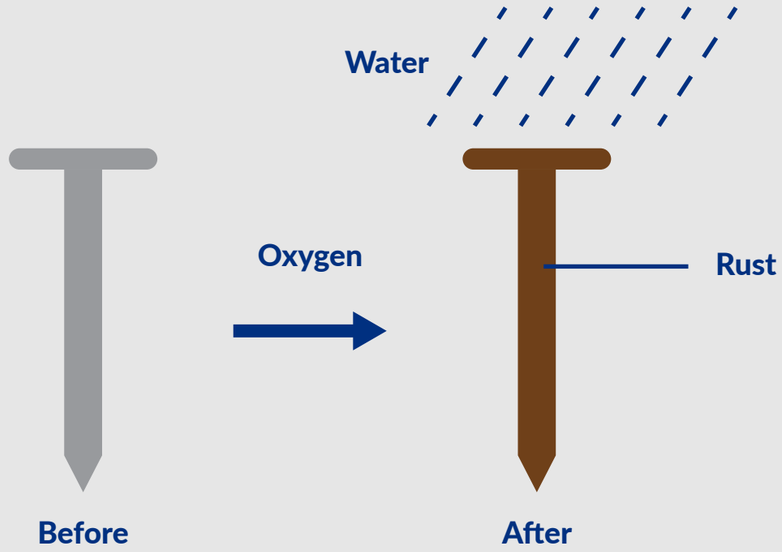
1.1.1 What is Corrosion?

Corrosion is an electrochemical reaction that occurs when a steel surface comes in contact with metal, water, humidity and oxygen.

Factors that cause corrosion to speed up include:

- **Humidity**
- **Temperature**
- **Water Soluble Salt**
- **Exposure to Air Pollution, Acid Rain, Soot & Dust Particles**

1.1.2 Corrosion of Steel



Rust is a reddish-brown, flaky, and friable oxide formed through a chemical reaction caused by the presence of water. Rusting is the process where iron or steel reacts with oxygen and water to form hydrated iron(III) oxide, commonly known as rust.

1.2
Inspection And Planning

Planning must be undertaken to maximise efficient use of resources. This includes allocation of ship crew manpower and volume of paint used.

1.2.1 Inspection & Maintenance Checklist

Actions	Indicators
1 **Check unknown existing coatings using a thinner test procedure**	• Refer to the type of coatings used previously and assess suitability • Common coating solutions available: Alkyds, Acrylic, Polyurethane, Epoxy 1. Chip off a small piece of coating 2. Put it in a small cup with NIPPON MARINE THINNER 600  If the piece remains intact, it is a two-component coating  If the piece dissolves quickly, it is most probably an acrylic  If the piece turns soft but does not dissolve, it is an alkyd coating
2 **Check Climate Condition**	• Check current weather conditions, forecast and time of day as temperature & humidity affects most types of paint Recommended Temperature: **10-30 ℃** Recommended Relative Humidity: Must be below **85%** Humidity Recommended Surface Temperature: **3 ℃** High *(Must be 3°C above the dew point of the air to avoid condensation)* • Must have adequate ventilation during and after paint application, especially in narrow and enclosed spaces such as tanks, warehouses, closed areas etc. • Take care that condensation will not be a risk on the freshly applied paint
3 **Check for Paint Defects**	• Identify the type of defects and its level of severity • Paint defects may include: Blistering, Corrosion, Orange Peel, Discolouration, Chalking, Detachment (or Flaking)
4 **Assessment of Work Scope**	• Define the size of the defect area(s) in sqm • Here are some quick indicators on the damage severity: Area: Localised/focused in an area or scattered Area: Large/medium or small Severity: Heavy/moderate or light
5 **Resource Allocation**	• Determine the manpower and hours required for each tasks: Cleaning and surface preparation; Paint application; Application interval (the time required for each coat to become fully cured)
6 **Health, Safety and Environment**	• Health, safety & environmental requirements and recommendations must be confirmed before paint application • Refer to Material Safety Data Sheet (MSDS) for more information. • Refer to Technical Data Sheet (TDS) for surface preparation and application of the product

1.2.2 Importance of Inspection and Planning

Assess and evaluate the coating condition of all areas to determine the extent of defects in need of repair.

Prioritise areas for maintenance in order of importance. For larger surface areas, divide the area into smaller sections for the ship's crew to manage.

Check existing coating type by referring to the OBM Chart/Scheme or *Technical Data Sheet (TDS)* to assure compatibility.

Calculate the paint volume needed for the maintenance areas. For film thickness and theoretical coverage, refer to *Technical Data Sheet (TDS)*.

Theoretical vs Practical

	Application Method	
	Roller / Brush	Airless Spray
Simple Structures	5 - 7%	20 - 30%
Complex Structures	10 - 15%	40% (including stripe coat)*

**This is applicable to a two-coat system. The relative loss for a single-coat system with a stripe coat on a complex area could be 60%.*

Above is an estimate of the possible loss of paint for a competent painter trying to achieve the minimum thickness specified with reasonable certainty. The extra paint needed beyond the theoretical spreading rate is highly dependent on the method of application, such as brush, roller, or spray, as well as the type of structure being painted. A simple shape with a high proportion of flat surfaces should not incur heavy losses, but if there are stiffeners or open lattice work involved, losses will be high.

When open lattice work is sprayed, no realistic estimate can be made of paint distribution loss. Some paint wastage is inevitable; paint may be spilled, a certain amount remains in used containers, and in the case of two pack materials, mixed paint may be left beyond its pot life.

(T.S.R) $m^2/L = \frac{SV\ R\ (\%) \times 10}{D.F.T}$ **(P.S.R)** $m^2/L = \frac{SV\ R\ (\%) \times 10}{D.F.T} \times (1 - Loss\%)$

Keep a painting record of the following:

Type of paint used | Application area | Paint volume used

Chapter 2

Understanding Root Causes of Paint Deterioration

2.1

Common Factors That Cause Paint Deterioration and Defects On Ships

Extreme Weather Conditions

Refers to the long term exposure to elevated weather conditions such as rain/storms, sunshine/UV rays, and/or snow.

Poor Preparation Before Painting Process

Inadequate surface cleaning, priming, or improper application techniques during painting can result in poor adhesion and premature paint failure.

Temperature Fluctuations

Extreme temperature changes, such as those experienced in cargo holds or engine rooms, can cause paint to expand and contract, leading to cracking and peeling.

Moisture and Humidity

Excessive moisture and humidity levels can promote mould, mildew, and moisture-related paint defects like blistering and bubbling.

Mechanical Abrasion

Mechanical actions, like rubbing against rough surfaces during loading or docking, can cause physical abrasion on vessels.

Chemical Exposure

Contact with chemicals, fuels, oils, and cleaning agents can cause paint to break down or lose its protective properties.

Chapter 3

Paint Defect and Inspection Assessment

3.1

Paint Defect Assessment

Sunshine / UV exposure

· Paint resin molecule broken down by UV rays
· Pigment undergoes chemical reaction with UV rays

Evidence

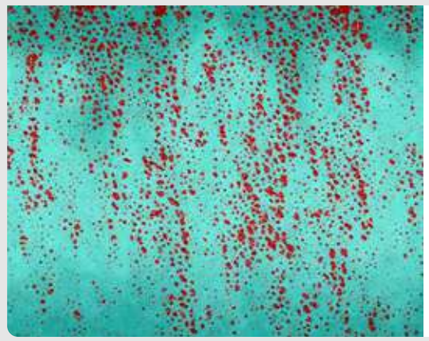
- **Chalking**
- **Cracking or Crocodiling**
- **Discolouration**

Rain / Snow

· Water seeps into paint films and/or layers

Evidence

- **Adhesion deterioration**
- **Corrosion**



Oxidation

· Increase oxygen exposure

Evidence

- **Blushing**
- **Cracking or Crocodiling**
- **Corrosion**

Variation in Humidity Level

· Strain of stress (repetitive swelling and shrinking due to humidity)

Evidence

- **Adhesion deterioration**
- **Cracking or Crocodiling**
- **Discoloration or Blooming**

Physical Abrasion

· Forced impact and friction caused by mechanical damages
· Friction caused by sailing on water

Evidence

- **Adhesion deterioration**
- **Partly damage**

Chemical Abrasion or Corrosion

· Water seeps through into paint films and/or layers
· Exposure to chemical which may weaken paint molecule

Evidence

- **Adhesion deterioration**
- **Blistering**
- **Discoloration**

Human Errors / Missed Areas / Holidays / Low Thickness Applied

· Incompatible coatings applied
· Poorly prepared surfaces and substrates before paint application
· Incompatible coating layers and/or thickness

Evidence

- **Cracking**
- **Corrosion**
- **Flaking**
- **Blistering**
- **Adhesion deterioration**

3.2

Paint Defect Cause and Remedy

Runs / Curtaining / Sagging

Refers to the excess application of paint so that runs, sags or drips occur

Cause

- Use of too much paint (slow by spray)
- Excess thinning
- Surface is too hard / glossy
- Surface temperature is too high (affects the viscosity)
- Surface temperature is too low (results in evaporation)
- Poor ventilation

Remedy

- Brush out before paint is dried/cured
- If paint has already dried/cured, abrade, wash or blast the surface

→ **Apply a fresh coat**

Orange Peel

Refers to the bumps in paint film resembling the skin of an orange

Cause

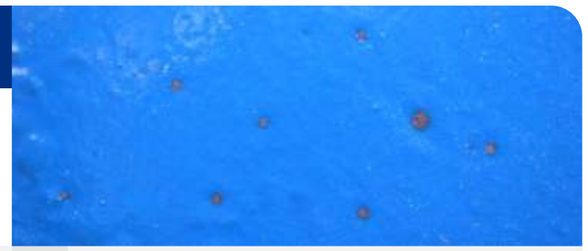
- Paint's viscosity is too thick
- Solvent evaporation rate is too fast

Remedy

- Brush out before paint is dried/cured
- If paint has already dried/cured, abrade, wash or blast the surface

→ **After surface preparation, reapply another coat or system**

Fish Eyes



Refers to the separation or pulling apart of wet film to expose to substrate or preceding coat

Cause

- Substrate contamination by oil/grease
- Silicone
- Dirt

Remedy

- Blast or treat with power tools to remove any contamination as needed

→ **Apply the original coat" to "After surface preparation, reapply another coat or system**

Blistering

Refers to the small/large broken and unbroken bubbles on the surface

Cause

- Solvent entrapment (insufficient air circulation)
- Osmotic blistering - Concentration of salt/oil/moisture (inadequate removal of contamination)

Remedy

- Blast or mechanically treated and wash substrate

→ **Apply the original coat**

Vacuoles

Refers to the void spaces inside paint film

Cause

- Pockets of solvent fumes or air inside half dried paint film

Remedy

- For small areas: Grind and wash
- For large areas: Abrasive blast

→ **Apply one or more coats of paint**

Lifting / Peeling

Refers to cracked or raised areas of paint that appear ready to detach

Cause

- Contamination on substrate or underlying coat
- Stress in paint film exceeds adhesion force

Remedy

- Consider blasting for removal of severe contaminations

→ **After surface preparation, reapply another coat**

Chalking

Refers to areas that leave a fine powder that transfers upon touch

Cause

· Degradation of resin component (UV light leaves loose pigment and fillers)

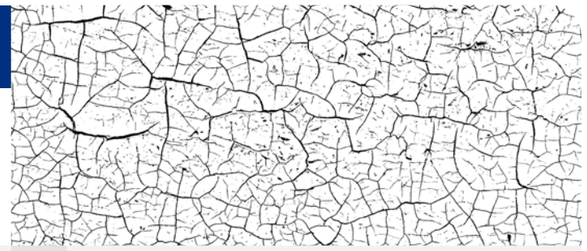
Remedy

· High pressure water jetting to remove underbound pigments and fillers

→ Apply UV resistant finish coat such as polyurethane finish

Cracking

(Hair-cracking, Checking, Crocodiling/Aligatoring, Crazing) Refers to the breakdown on the surface or in the paint film



Cause

· Paint shrinkage
· Limited paint flexibility
· Excess thickness
· Paint applied/cured at too high temperature
· Mechanical influences
· Different expansion rates
· Soft underlying coat

Remedy

· For small areas: Abrade / wash total system
· For large areas: Blast

→ Reapply coat(s)

Blushing

Refers to a flat finish with a milky appearance

Cause

· Precipitation or moisture on fresh paint during curing process
· Amine flotation due to cold/damp conditions in high humidity causing an oily surface to form

Remedy

· Wash with water/ thinner

→ Reapply coat

· Abrade / wash

→ Reapply coat

· Blast

→ Reapply coat

Pinpoint Rusting

Refers to scattered minor rust points

Cause

· Pinholes in paint film
· Steel surface profile too high
· Paint film too thin
· Particle contamination under paint film

Remedy

· For small areas: Abrade/ wash total system
· For large areas: Blast

→ Reapply coat(s)

To prevent pinpoint rusting:
· Control surface profile
· Control the dry film thickness (DFT)
· Use holiday detector to localise pinhole

Pinholes

Refers to tiny holes that appear in a dried paint film

Cause

· Contaminants or imperfections on the surface
· Poor mixing or inadequate stirring
· Air trapped in the paint during application or mixing.
· Rapid evaporation of solvents can cause bubbles that lead to pinholes.
· High paint viscosity

Remedy

· For small areas: Abrade/ wash total system
· For large areas: Blast

→ Reapply coat(s)

To prevent pinholes:
· Stir well before use
· After mixing, allow 10-15 minutes for entrapped air bubbles to release.
· Control surface profile and cleanliness
· Adjust viscosity by proper dilution

Chapter 4

Products and Paint Systems

4.1

Introduction to SEASTOCK Series

Maintaining a marine vessel is crucial to ensure its smooth and efficient operation, as well as the safety of its crew and passengers. One important aspect of onboard maintenance is choosing the right paints to protect the vessel from the harsh marine environment.

With Nippon Paint Marine's SEASTOCK Series, we ensure crew members can keep the vessel in great condition with minimum effort. Our coatings are easy to apply on a wide range of substrates, and can be used throughout the vessel to simplify maintenance.

With our global presence, we can deliver coatings when our customers need them, wherever the ship is located.

4.2

Paint Systems

SEASTOCK SERIES

E-MARINE MAX

Function	Epoxy Primer & Finish (Quick Dry)
Volume Solids	58±2%
Typical DFT	75 ~ 100 µm
Theoretical Coverage	8.13m² / L (75µm)
Mixing Ratio by Volume	BASE 5.5 / HARDENER 1
Drying Time @ 25°C	Surface dry: 2.5 hours | Dry hard: 4 hours
Application	· Deck · Cargo Holds · Superstructures · Outside Shell · Accommodation (Exterior) · Fore Mast, Aft Masts · Funnel (Exterior) · Void Spaces · Pipes · Exterior Deck Machinery

NEOGUARD 100

Function	Epoxy Primer & Finish
Volume Solids	61±2%
Typical DFT	100 ~ 200 µm
Theoretical Coverage	6.10m² / L (100µm)
Mixing Ratio by Volume	BASE 3.8 / HARDENER 1
Drying Time @ 25°C	Surface dry: 1 hour | Dry hard: 12 hours
Application	· Topsides · Decks · Superstructures · Cargo Holds · Engine Room · Pump Room · Void Spaces · Cofferdams

NEOGUARD BULCON

Function	Epoxy Filler
Volume Solids	90±2%
Typical DFT	1.0 ~ 2.0 mm
Theoretical Coverage	0.90m² / L | 0.625m² / kg
Mixing Ratio by Volume	BASE 1.5 / HARDENER 1
Drying Time @ 25°C	Surface dry: 2 hours | Dry hard: 16 hours
Application	· Exposed areas · Immersed areas · Internal areas · Other ships areas (welding lines, edges, etc.)

A-MARINE FINISH

Function	Acrylic Finish
Volume Solids	44±2%
Typical DFT	30 ~ 50 µm
Theoretical Coverage	12.57m² / L (35µm)
Mixing Ratio by Volume	Single Pack
Drying Time @ 25°C	Surface dry: 20 minutes | Dry hard: 1 hour
Application	· Boottop · Topsides · Decks · Superstructures

O-MARINE PRIMER

Function	Alkyd Primer
Volume Solids	48±2%
Typical DFT	30 ~ 80 µm
Theoretical Coverage	12.01m² / L (40µm)
Mixing Ratio by Volume	Single Pack
Drying Time @ 25°C	Surface dry: 30 minutes | Dry hard: 7 hours
Application	· Accommodation (Interior) · Steering Gear Room, Bosun Store · Engine Room

O-MARINE FINISH

Function	Alkyd Finish
Volume Solids	45±2%
Typical DFT	30 ~ 40 µm
Theoretical Coverage	12.86m² / L (35µm)
Mixing Ratio by Volume	Single Pack
Drying Time @ 25°C	Surface dry: 30 minutes | Dry hard: 7 hours
Application	· Superstructures (Interior & Exterior) · Decks

U-MARINE FINISH

Function	Polyurethane Finish
Volume Solids	62±2%
Typical DFT	25 ~ 50 µm
Theoretical Coverage	20.66m² / L (30µm)
Mixing Ratio by Volume	BASE 5 / HARDENER 1
Drying Time @ 25°C	Surface dry: 40 minutes | Dry hard: 1 hour
Application	· Topsides · Superstructures

Heat Resistant

TETZSOL 200 SILVER M

Function & Product Type	Alkyd Finish (up to 150°C)
Volume Solids	40±2%
Typical DFT	20 ~ 30 µm
Theoretical Coverage	16.00m² / L (25µm)
Drying Time @ 25°C	Surface dry: 1 hour | Dry hard: 4 hours
Application	· Boilers · Engines

TETZSOL P-200 ECO

Function & Product Type	Silicone Alkyd Primer (up to 200°C)
Volume Solids	42±2%
Typical DFT	20 ~ 30 µm
Theoretical Coverage	16.80m² / L (25µm)
Drying Time @ 25°C	Surface dry: 20 minutes | Dry hard: 4 hours
Application	· Boilers · Engines · Radiators

TETZSOL 200 ECO

Function & Product Type	Silicone Alkyd Finish (up to 200°C)
Volume Solids	29±2%
Typical DFT	10 ~ 15 µm
Theoretical Coverage	29.00m² / L (10µm)
Drying Time @ 25°C	Surface dry: 20 minutes | Dry hard: 4 hours
Application	· Boilers · Engines

TETZSOL P-500 ECO

Function & Product Type	Silicone Primer (up to 500°C)
Volume Solids	36±2%
Typical DFT	20 ~ 30 µm
Theoretical Coverage	14.40m² / L (25µm)
Drying Time @ 25°C	Surface dry: 20 minutes | Dry hard: 4 hours
Application	· Boilers · Funnels

TETZSOL 500 ECO

Function & Product Type	Silicone Finish (up to 500°C)
Volume Solids	22±2%
Typical DFT	10 ~ 15 µm
Theoretical Coverage	22.00m² / L (10µm)
Drying Time @ 25°C	Surface dry: 20 minutes | Dry hard: 4 hours
Application	· Boilers · Funnels

Thinner

Thinners	Description / Use
NIPPON MARINE THINNER 100	O-MARINE Series / Typical alkyd paint
NIPPON MARINE THINNER 200	A-MARINE Series / Typical acrylic paint
NIPPON MARINE THINNER 500	TETZSOL Series / Typical silicone heat-resistant finish
NIPPON MARINE THINNER 600	E-MARINE Series, NEOGUARD Series, Typical epoxy paint
NIPPON MARINE THINNER 700	U-MARINE Series / Typical polyurethane paint

Chapter 5

Preparation and Application of Paint

5.1

Surface Preparation

1. Understand paint compositions and drying/curing methods

Before paint application, first determine the properties of the paint based on the type of binder. A binder is used to bind different pigments and extenders together to form a solid paint film. The properties of paint film depend on how the binder dries or cures.

In liquid paints where solvent is involved, drying is a two step process. This transformation in the paint is known as drying or curing. The paint films formed by drying / curing methods are different from the original binders and will not re-dissolve in their original solvent.

The three most common drying/curing methods are:

1. Physical Drying
2. Oxidative Curing
3. Chemical Curing

Paint Composition	Drying / Curing Methods	Process
Acrylic Paint	**Physical Drying**	1. Solvent evaporates 2. Binder's molecules link together and then dissolve to form a paint film **This method does not involve any chemical bonds*
Alkyd Paint	**Oxidative Curing**	1. Solvent evaporates 2. Binder's molecules link together through atmospheric oxygen (known as oxidation) to create a chemical reaction
Epoxy/ Polyurethane Paint (two components)	**Chemical Curing**	1. Solvent evaporates 2. Component A & B molecules move to link together through a chemical reaction - This creates a three dimensional network that results in a solid paint film

Curing Conditions

Factors that must be considered when marine coatings are applied:

1. Condition of the substrate
2. Temperature
3. Relative humidity
4. Weather conditions
5. Condensation
6. Ventilation
7. Ultraviolet light (UV)
8. Dry time/return to service

2. Select the right treatment methods for defect areas

For basic removal of oil, grease, loose coating, dirt , salt, chalk powder and other less stubborn defect surfaces, use these treatment methods:

Chemical cleaning
To remove grease/oil from the surface with effective cleaners such as water soluble detergent

Fresh water hosing
To remove contamination such as salt, stains, oil, grease, chalking dust

Hand/Manual tools
- Wire brushing
- Scrapers
- Chipping hammers/chisels
- Rust-pickers
- Abrasive papers

Power tools
- Needle gun
- Disc sander

For more stubborn defect surfaces with hard-to-remove residual dust, paint flakes, debris, dirt, grime, coatings and other hard deposits, use these mechanical treatment methods:

Power tool cleaning

The effectiveness of this method depends on the effort and endurance of the operator. Some of these methods include:
- Mechanical descaling (needle guns, rotary peening)
- Rotary wire brushing
- Rotary power discing
- Power grinding/sanding

Spot blasting

This method is commonly used on the outside of ship hulls during repair and maintenance work when patches of localised corrosion have occurred. Important things to note when using this method:
- Take care not to undercut and loosen the paint edges around the cleaned spot.
- Beware of stray abrasive particles (ricochet damage) as it will damage surrounding paint in confined spaces.
- Discontinue spot blasting when moving from one spot to the next to avoid trailing blast media over the surface.

3. Standard for surface preparation

The durability of anticorrosive paint on steel largely depends on how well the surface is prepared beforehand. It is also crucial to clearly specify the required quality of preparation for each case.

The internationally used standards for surface preparation using power tools are shown in the following diagram. The standards including ISO, SSPC and NACE provide the degree of rust removal for the steel that is applied with no shop primer.

Regarding secondary surface preparation for the shop-primed steel, the Shipbuilding Research Association of Japan stipulated the "Standard of Steel Surface Preparation" (JSRA-SPSS).

For reference, we have included photos of rust grades and levels of treatment according to ISO 8501-1.

Hand and Power Tool Cleaning

Rust Grades / Preparation Grades	ISO8501-1 A	ISO8501-1 B	ISO8501-1 C	ISO8501-1 D	Various standards (For Reference) SSPC	NACE	JSRA
	Steel surface largely covered with adhering mill scale but little, if any, rust.	Steel surface which has begun to rust and from mill scale has begun to flake.	Steel surface on which the mill scale has rusted away or from which it can be scraped, but with slight pitting visible under normal version.	Steel surface on which the mill scale has rusted away and on which general pitting is visible under normal version.			
Thoroughly hand and power tool cleaning When viewed without magnification, the surface shall be free from visible oil, grease and dirt, and from poorly adhering mill scale, rust, paint coatings and foreign matter.	-	B St 2	C St 2	D St 2	SP 2	-	Pt 1
Very thoroughly hand and power tool cleaning As for St 2, but the surface shall be treated much more thoroughly to give a metallic sheen arising from metallic substrate.	-	B St 3	C St 3	D St 3	SP 3	-	Pt 2 Pt 3

Rust Grades

Preparation

The effective life of a coating of anti-corrosive paint applied to a steel surface is to a very large extent dependent on how thoroughly the surface has been prepared prior to painting. It is also important to be able to specify clearly the quality of preparation required in each particular case.

Accordingly a Standard has been approved, specifying four grades of rusting and a number of preparation grades, each establishing a quality grade or preparation prior to protective painting required on a steel surface in a standard rust grade. These grades are presented in this Standard as a series of prints, which provide a clearer and more rapidly appreciated definition than a verbal description.

The standard has been prepared by the Swedish Corrosion Institute in cooperation with the American Society for Testing and Materials, ASTM, and Steel Structures Painting Council, SSPC, USA. In the specifications relating to preparation of surfaces prior to painting, the SSPC and SIS designations correspond as follows:

SSPC-Vis 1	SIS 05 59 00
SSPC-SP5	A Sa 3, B Sa 3, C Sa 3 and D Sa 3
SSPC-SP10	A Sa 2½, B Sa 2½, C Sa 2½ and D Sa 2½
SSPC-SP6	B Sa2, C Sa 2 and D Sa 2
SSPC-SP7	B Sa1, C Sa 1 and D Sa 1

Preparation Grades.
Scraping and wire-brushing
C St 2

Preparation Grades.
Scraping and wire-brushing
C St 3

4. Final cleaning before painting

It is strongly recommended to clean any contamination from the surface before painting to ensure the surface is thoroughly clean & dry before painting.

We recommend a combination of vacuuming and air blowing, and we recommend cleaning with a solvent (thinner) for contamination such as oil that cannot be removed by these methods.

Washing | **Bristle brush** | **Vacuum cleaner**

5.2
Steps of Paint Preparation

1. Storage

Store the paint in a dry shaded area, preferably in the paint locker away from heat and ignition sources

- Assess and secure areas to store flammable liquids or gases that may ignite when using mechanical power-tools
- Ensure good ventilation during painting operation
- Remove all naked light and unprotected electrical equipment while painting
- Keep paint store organised
- Use the older stock first
- Store primers and finishes in dedicated areas
- Keep the lids on paint and solvent drums
- Dispose of waste solvent and rags correctly
- Keep hardeners with the respected bases

2. Products and Safety

Before the actual paint application, please read the instructions in the Marine Paint Manual of Nippon Paint Marine

**Refer to Technical Data Sheet for more information.*

3. Paint Mixing and Thinning

For one component paint:

- Use a mechanical mixer to stir the paint for a minimum of two minutes until the paint is homogenous

For two component paints (base & hardener)

- Mix in correct ratio with a mechanical mixer for a minimum of two minutes until the paint is homogenous
- For a smaller quantity, use a measurement cup to ensure correct mixing ratio

Paint Mixing Result

- Paint mixture must be completely uniformed without signs of lumps and sediments
- Correct mixing ratio = better paint performance

4. Induction Time and Pot Life

Induction Time is the time required for pre-reaction of the two components (base & hardener) in the drum prior to the application

Pot Life is the maximum elapsed time the two component paints (base & hardener) are usable after mixing

Factors to avoid that result in shortened pot life
- High temperatures
- Cover the open drum with a cloth to prevent solvent loss

**Refer to Technical Data Sheet for more information.*

5.3
Environment of Paint Application

1. Ventilation

Ensure sufficient ventilation when painting inside a narrow and confined space

- Tanks
- Stores
- Void Spaces

2. Air Temperature

Air temperature conditions must be ideal as it may affect the drying time, as well as the film thickness

Example:
- Low temperature causes slow curing time
- High temperature causes faster drying time

Recommended Air Temperature: 10 - 30°C

3. Steel Temperature

Condensation happens when the steel temperature is below the atmosphere's dew point.

Example:
- Low temperature delays the curing time and causes running, sagging and curtaining
- High temperature results in immediate curing and porous coatings

Recommended Steel Temperature: 3°C above dew point

4. Relative Humidity (RH) and Dew Point

Paint application should not be done during high relative humidity conditions such as rain, snow, fog or mist as these weather conditions cause condensation

Dew point is the temperature at which the humidity in the air will cause condensation

- Use a humidity metre to measure the dry/wet air temperature reading, relative humidity and dew point
- Relative humidity should not be above 85%

5.4

Paint Application Methods

Manual Methods

Paint Brush

For difficult to reach areas and good coverage

Apply stripe coats on areas such as:
- Welding seams
- Corners
- Edges
- Small fittings

Roller

- Faster application than paint brush
- Suitable for uniformed finish coating and marking in accordance with difficult to apply thick coats
- Suitable for painting interior spaces

**Multiple coats may be necessary in order to achieve the recommended thickness*
**Single coat applications by roller is not recommended for primer/anticorrosive paints*

5.5

Paint Application Checklist

Surface Preparation

The quality of surface preparation stands as the paramount factor influencing paint performance. Emphasising the significance cannot be overstated, as it entails the removal of oil, grease, previous coatings, rust, and other surface impurities.

The following process is recommended:

- **Fresh water hosing**
- **Chemical cleaning**
- **Hand / manual tools**
- **Power tool cleaning**
- **Steel preparation**
- **Hard scraping**
- **Chipping hammers**
- **Wire brushing**

Steps

1. **Cleaning**
   - Use water-soluble detergent and high-pressure fresh water.
   - Eliminate salt, oil, grease, loose coatings, dirt, and residual detergent.
2. **De-rusting**
   - Merge rust patches by removing paint between them.
   - Manual or mechanical methods.
   - Feather vulnerable edges with grinding or sanding.
   - Avoid over-polishing surfaces for better adhesion.
3. **Remove Particles**
   - Ensure complete removal of particles or debris.
   - Utilise available clean air when possible.
4. **Avoid Contamination**
   - Apply paint promptly after preparation.
   - Prevent contamination, elevated salt levels, and flash rust on bare metals.

Overcoating Intervals

Some paints have a minimum and maximum overcoating interval, otherwise known as drying time and full curing time.

Defects that may occur when:

- **Overcoating interval is less than the minimum**
  - Solvent retention/entrapment
  - Insufficient curing
- **Overcoating interval is more than the maximum**
  - Detachment
  - Paint breakage/flaking

**Refer to Technical Data Sheet for more information.*

3 Drying and Curing Time

After paint application, provide sufficient ventilation and/or heating to dry and cure properly, especially in narrow and enclosed spaces

Drying and curing time are affected by air temperature

- At a low temperature, paints become thicker
  **It is recommend to warm up the paints until they reach a suitable viscosity*
- At high temperature, paints develop low viscosity and have a tendency to dry up

Recommended air temperature for paint application: 10 - 30°C
Recommended steel surface temperature : Above 5°C | Not above 40°C

4 Dry Film Thickness (DFT) Control

Wet Film Thickness (WFT) checks can be used to predict DFT. WFT can be checked using WFT gauges or combs. (an image of how it's done would help).

DFT is important for corrosion control and paint performance

Wet Film Thickness (WFT) is used to predict DFT

- Too low film thickness causes early corrosion due to poor protection
- Too high film thickness causes overconsumption, loss of adhesion, cracking, solvent entrapment, and early paint deterioration

5 Cleaning of Equipment Tools

After paint application, all equipment tools require thorough cleaning/washing (potentially with thinner)

- **Paint brush**
- **Roller**
- **Pump**
- **Paint hose**

6 Final Steps/ Overview

For safety purposes, rope off painted area and put up a "Keep Out" sign to ensure others keep out of painted area

APPENDIX

Health and Safety Guidelines

1. Material Safety Data sheets (MSDS)

Read and check the products in the Material Safety Data Sheet (MSDS).

2. Personal Safety

Do not let the paint touch your skin by wearing the appropriate protective clothing

- **Overalls/Tulum**
- **Safety helmet**
- **Safety shoes**
- **Gloves**
- **Dust mask**
- **Goggles/Safety glasses**
- **Ear protectors/Earplugs**

***Wear a gas mask in confined spaces*

If paint should touch your skin, remove it with soap and hot water or an industrial cleaner (Do not use a solvent/thinner)

Obey all safety rules and regulations at all times

3. Paint Material Safety

Paint materials should be arranged in a tidy manner in the paint locker to ensure they are kept from overturning or leaking

- **Equipment stacked neatly**
- **Paints tied tightly to prevent tipping and leaking**
- **Ensure good ventilation**
- **Ensure suitable temperature**
- **Materials & containers must be disposed of as hazardous waste**

Good ventilation in the paint locker is crucial to prevent paint fumes from filling up the space

Refer to Product Data Sheets and Material Safety Data Sheets (MSDS) for

- **Flash Point**
- **Ignition Point**

3. Fire & Explosion Hazard

To avoid any fire and explosion hazards, ensure the following is not near any paint applications
- **Lighter**
- **Matches**
- **Cigarettes**

In case of a fire
- **Use a dry chemical foam or CO_2 extinguisher**
- **Protect yourself from the fumes by using breathing apparatus such as respirator masks**
- **Do not extinguish the fire with water as paint solvents float on water and this will cause the fire to spread**

Various Paint Suitability Table for Overcoating

Top Coat / Under Coat	O-MARINE FINISH	A-MARINE FINISH	U-MARINE FINISH	E-MARINE FINISH	NEOGUARD 100	E-MARINE MAX
Alkyd	A	NA	NA	NA	A	A
Acrylic	NA	A	NA	NA	A	A
Polyurethane	NA	LA	A	LA	A	A
Epoxy Fnish	NA	LA	LA	A	A	A
Epoxy A/C	NA	A1	A1	A1	A	A

A Acceptable
NA Not Acceptable
A1 Light discing, or sandpapering are required to make an anchor profile (if max overcoating interval time exceeds).
LA Sealer coat is required. (Epoxy primer is recommended to apply as sealer coat)

※ Salt residue and various types of dirt, dust, and grease should be removed before application.

***Please contact your local Nippon Paint Marine Representative for the Onboard Maintenance Chart.**

GLOSSARY

Terms in Onboard Maintenance and Ship's Coating Specifications

Abbreviation	Definition of Term	Description
OBM	Onboard Maintenance	The plan used for the ship's regular coating repairs
WFT	Wet Film thickness	The measurement in microns taken with a wet film thickness comb just after application. This gives an idea of the final (dry) film thickness
DFT	Dry Film Thickness	The measurement of the total film thickness applied in microns. It is taken with a magnetic electronic gauge when the coating system has cured hard.
F/C	Full Coat	A paint system applied over the entire surface of an area
T/U	Touch Up	A coat of paint applied partially over some areas but not the entire area. It is usually estimated as a percentage of the full coat
S/C	Stripe Coat	A coat of paint applied to areas that are difficult to Access or having a design such that reaching the correct thickness will be difficult to achieve. Stripe coats are always recommended when painting edges and stiffeners.
TSR	Theoretical Spreading Rate	Usually given as m^2/Ltr. The spreading rate of the paint based on its svr and dft.
PSR	Practical Spreading Rate	Usually given as m^2/Ltr. The spreading rate of the paint based on its tsr less the expected losses.
SVR	Solid Volume Ratio	Percentage of solids content in the paint. (Wft x svr) / 100 = dft
	Primer	Product used as the first coat in a system to provide some anticorrosion protection
	Finish	Product specified as the final coat in a system
	Primer/Finish	A product designed to work as both primer and finish.
	Thinner	Used to assist application in case the product is too thick to apply easily. Also used as a cleaner for tools and equipment.
ISO 8501-1	(International Standard Organisation)	
SSPC	(Steel Structures Painting Council)	
NACE	(National Association of Corrosion Engineering)	
JSRA - SPSS	(Japanese Ship Research Association)	

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