A Guide to

Hull Painting of Ships

For Ship Owners, Superintendents and Seafarers

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Author's Profile

S.N BATRA

Retired Marine Engineer / Superintendent

Mr. S.N. Batra studied in Aitchison College, Lahore (before Independence of India), St. Columba's School , and St Stephens College in Delhi. He did his Marine Engineering from DMET , Calcutta, 1951-55 batch and was a Merit Scholarship holder for three years.

He worked with SCI India Steamship and the Shipping Corporation of India (SCI), Chief Engineer for five years, with a short spell of six months as a lecturer for pre and post sea students at DMET Calcutta. He was then promoted as Deputy Engineer Superintendent in SCI Calcutta office in 1964, where he worked till 1979, heading the Technical Department and in-charge of all technical operations, surveys, repairs and dry-docking of ships, along with managing and posting of ship's technical personnel.

Due to rapid expansion of the SCI fleet in the 60s and 70s, there was an acute shortage of ship engineers. During that time, Mr. Batra started and supervised the very successful "One year Graduate Engineers Training Scheme". He was then transferred to the SCI Head Office in 1979, as Chief Technical Manager in the Liner and Passenger Ships Division and was in charge of over 90 ships. Later on, he was posted at Tokyo for four years in 1986 to 1990 as Regional General Manager, Japan and Far East and then back to the Liner Division at the head office as Group General Manager.

On retiring from SCI in 1992, Mr. Batra joined Bay Container Service and was in-charge of the all India operations of their Container Depots. During his tenure in BCT, he was responsible for setting up new Container storage and repair depots in New Mumbai and on the outskirts of Delhi.

On the onset of the new century, Mr S.N. Batra retired after 45 years of continuous service and started teaching at various training establishments. He still takes interest in the training and education of Marine Engineers and is a visiting faculty of some well known maritime training institutes in Mumbai.

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INTRODUCTION

Introduction

Apart from complying to dry docking regulations for ship's maintenance, a ship owner is also required to assess, clean and repair underwater portions and systems of the ship to ensure that the fuel efficiency and speed are maintained for avoiding unwanted losses in the profit margin.

The main intention for bringing a commercial ship in the dry dock is to check, clean and repair the hull of the ship. This vital job is performed by dry dock contractors.

However, it has been commonly observed that the staff responsible to look after the cleaning and painting of the ship's hull in dry dock does not have the in-depth knowledge of operations and requirements involved, which is essential for efficient hull paint operation.

Introduction

The shore workshop or the company responsible to clean and paint the hull can overlook many aspects of the painting operation, which eventually may lead to poor hull surface and undermine the whole intent of bringing the ship to the dry dock.

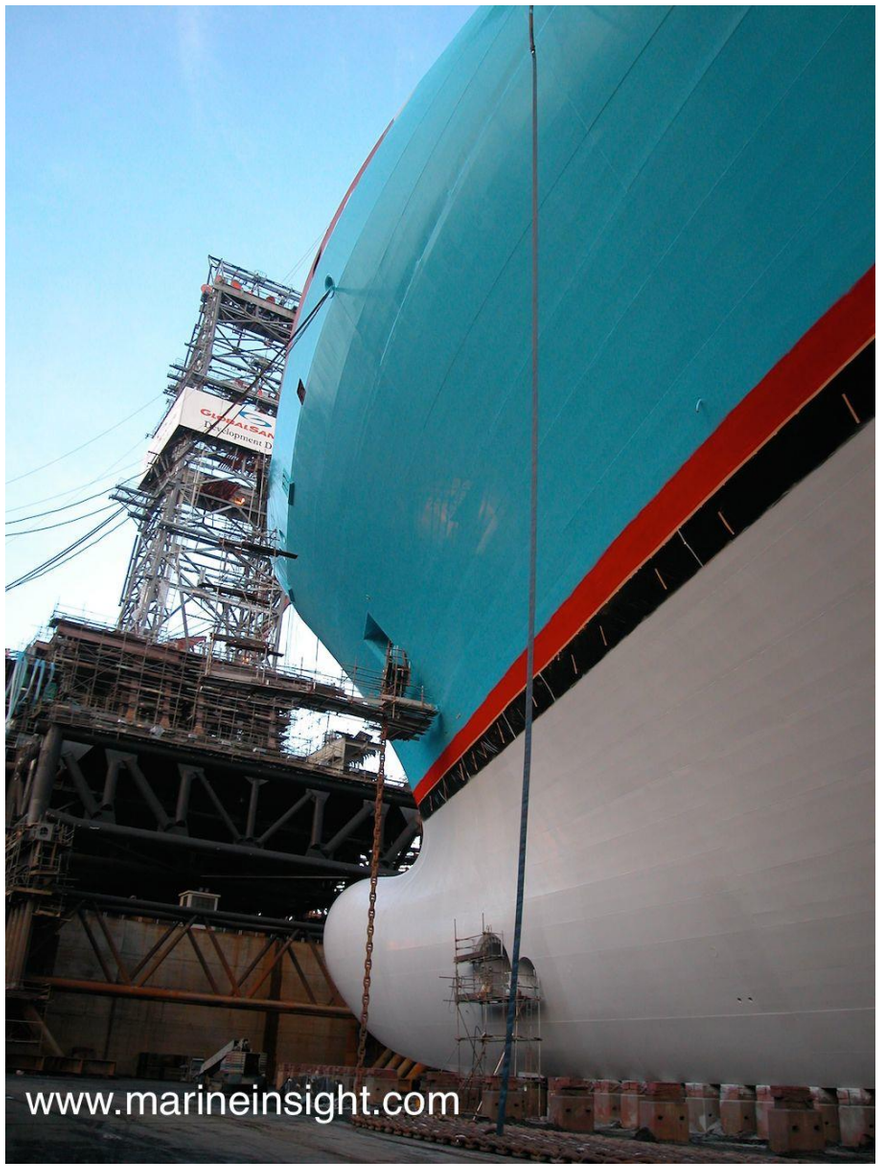
Some of the important aspects that need to be considered while attending ship's underwater areas in dry dock are:

- To clean and paint the hull
- When structural changes/ modification needs to be performed on the ship
- Assess the nature of damage to the ship's hull after accident, grounding etc.
- Guarantee dry-docking*
- Mandatory inspection of underwater portion, propeller and rudder not exceeding the interval of 2.5 years

Introduction

- When there is exchange of hands for ship owner (selling/buying of vessel)

- To repair the essential damage happened to the ship’s hull

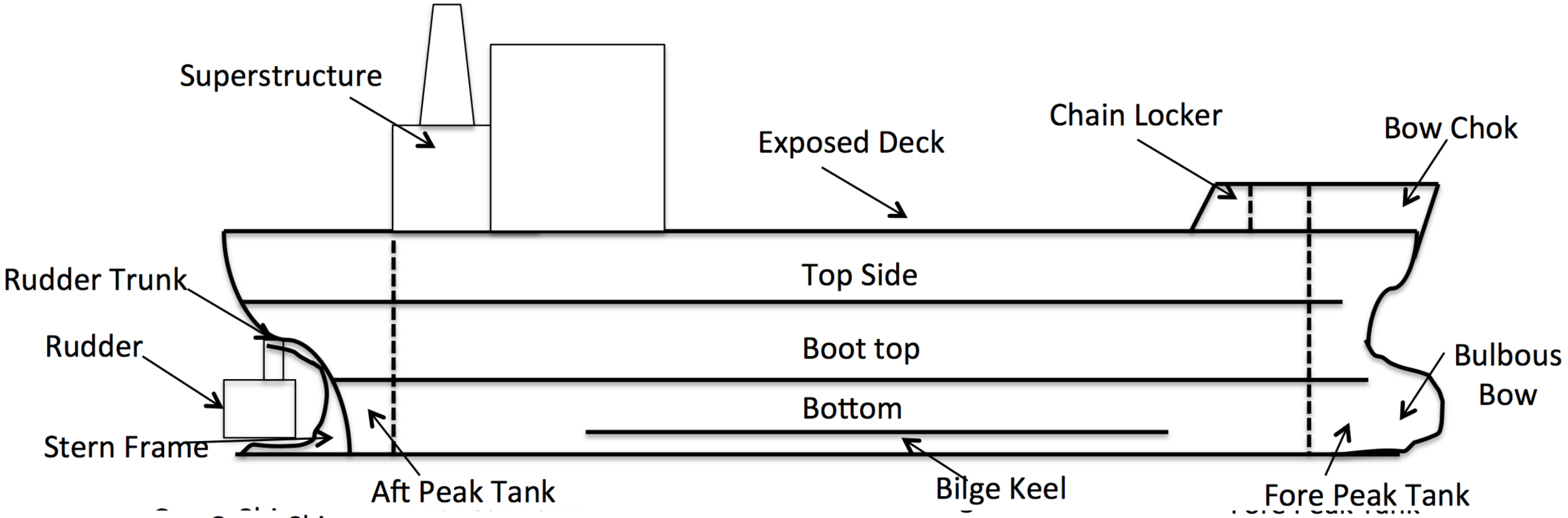


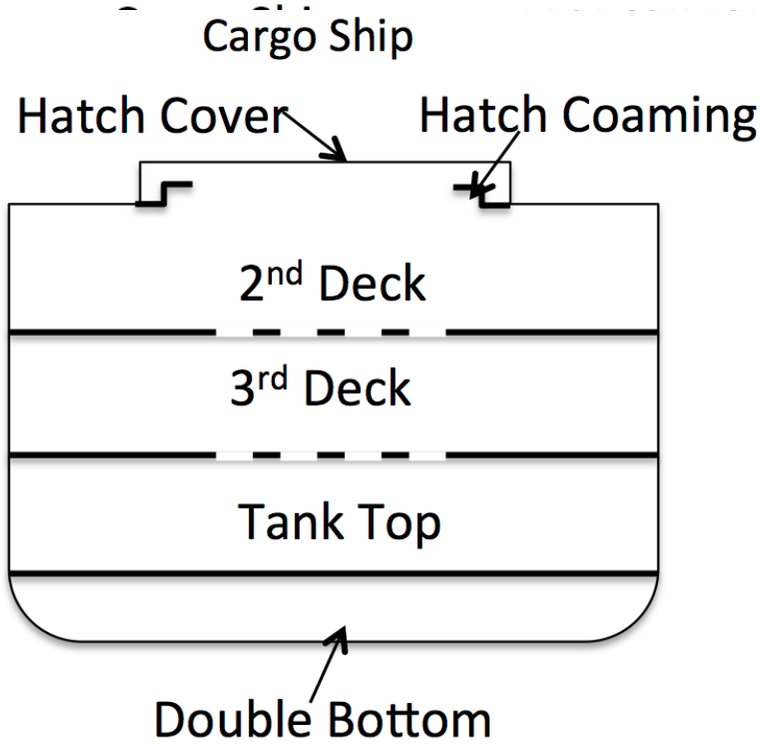
* When ordering a ship and after detailed negotiation, the ship-owner and the shipyard sign a formal contract. One of the clauses in such a contract includes shipyard’s guarantee for the performance of the equipment fitted, which is tested during the ship’s trials before delivery.

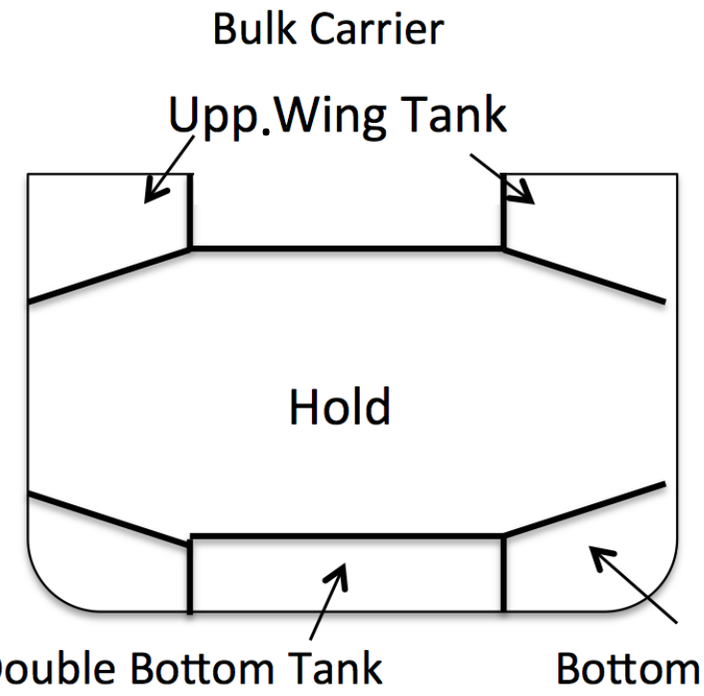
However, the underwater portion of the ship including the propeller, rudder and other fittings are checked during the first dry docking of the ship. Any defect in the underwater section of the ship, including the propeller, rudder etc. is brought to the notice of the shipyard and repaired on the builder's account

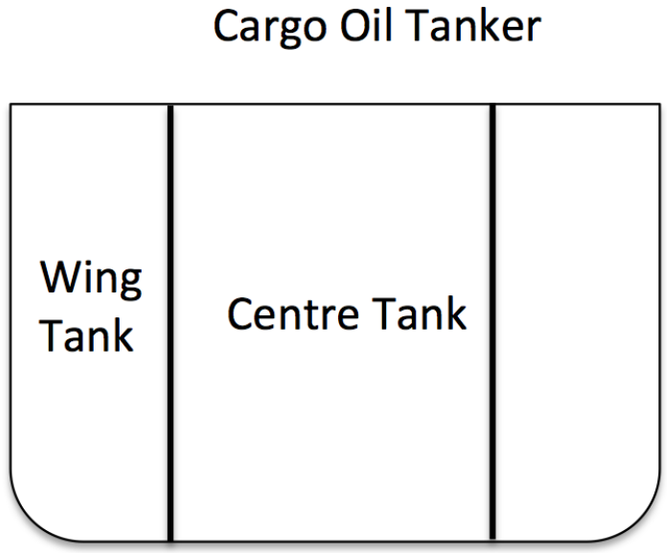
This first dry docking is therefore known as "Guarantee dry docking”.

Ship Areas Considered for Different Paint Applications









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COSTING

Costing

The owner and the superintendent of the dry docking ship have to keep a track of different types of costing (Fuel oil, lube oil, port charges, spare parts etc.), which are involved in the ship operation before taking a note of overall hull painting cost. Master and chief engineer assist them in providing all the required data from the ship. There are two main types of operational costs which are involved:

1. Indirect Operational Costs
2. Direct Operational Costs

Indirect Operational Costs (IOE):

The indirect cost addresses the expenses incurred when the ship is not sailing. This cost also includes wages paid to the ship's crew and shore staff, who are involved in the direct operation of the ship. Insurance, vessel management, repairs and stores are to be included in the indirect costs and the cost of finance and depreciation are to be calculated on per day basis.

Costing

When the ship is in port, following are common expenses incurred:

- Standing Charges
- Crew wages
- Victualing
- Fuel and lube oil charges
- Fresh water consumption charges
- Port and agent fees

Apart from various expenses incurred when ship is in the port, some other important expenses are:

- Insurance cost

- Vessel management cost

- Vessel repair cost

- Cost for spares and stores

Direct Operational Costs (DOE):

Direct operational costs involve all the expenses of ship's sea voyage. Following are the most important expenses:

- Cost of fuel at sea on per day basis

- Cost of lube at sea on per day basis

- Cost of fresh water at sea on per day basis

- Cost of tugs and pilots

Costing

- Other port and transit related charges

Therefore, the total operating cost of a ship on a voyage is = **I.O.E + D.O.E**

It is very important, especially for the shore management and superintendent, to keep a record of ship's costing. Same can be used to understand the increase in the fuel consumption and to compare the data between fouled hull and cleaned hull once the ship comes out of the dry dock.

Dry Dock Costs

Dry docking is the most expensive repair operation which is carried out on ship at regular intervals of time. The person in-charge (ship's superintendent) of dry docking must know various costs involved when the ship is laid up on the dry dock blocks. Following are the important expenses related to dry dock and hull painting:

Dry Dock Hire Rate on Per day basis (US $):

First and Last day: L X B X 1
Other days: L X B X 0.5

High Pressure Jet Cleaning:

Flat Bottom 0.75 – 1 US$/ SQ. MTR
Vertical Sides 0.85 -1.25 US$/ SQ.MTR
Top Sides 0.95- 1.5 US$/ SQ.MTR

Costing

Washing Down:

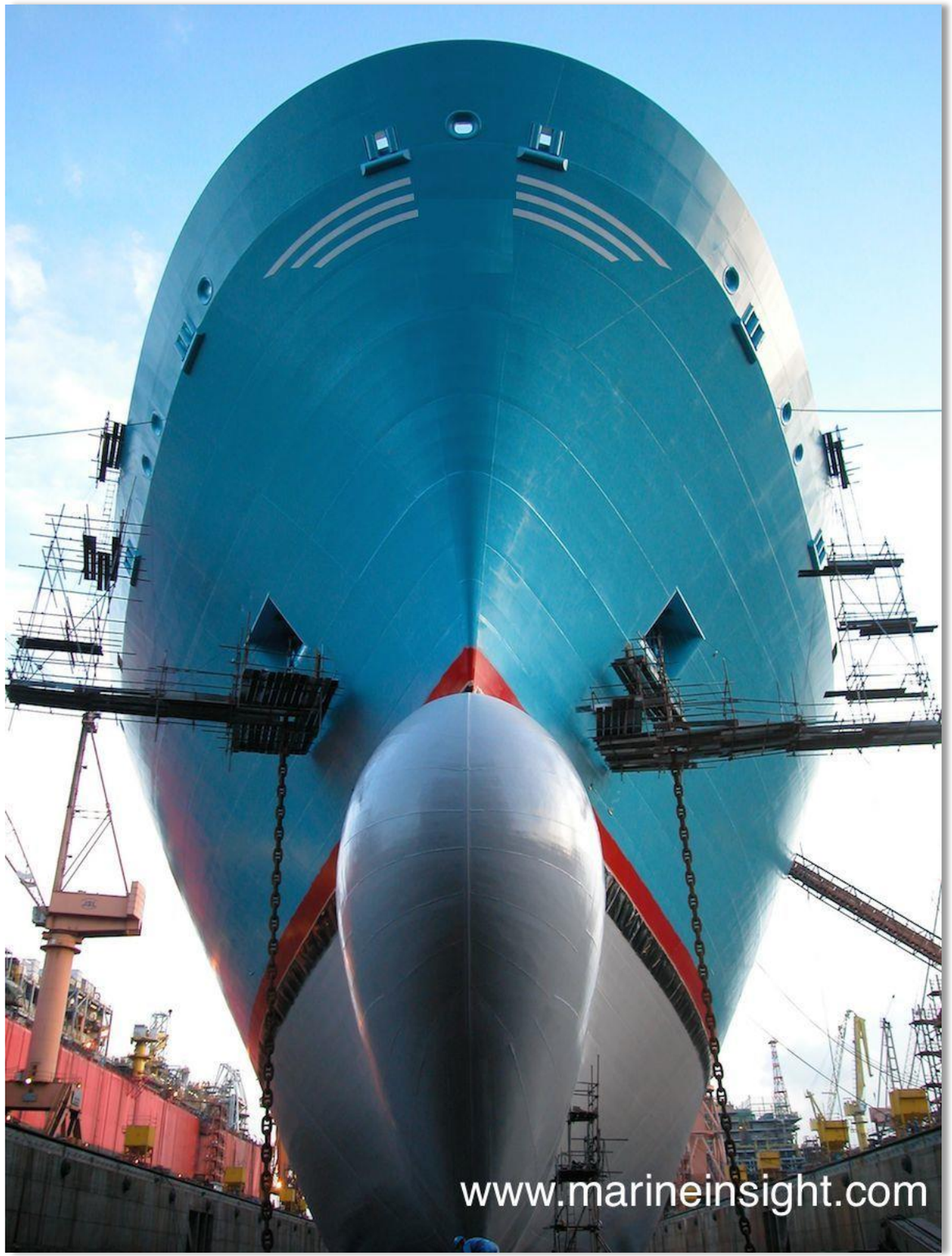
Vertical Side: 2 – 2.5 US$/ SQ. MTR
Chemical Wash: 3 – 4 US$/ SQ. MTR

Grit Blasting to Sa 2.5

Flat Bottom: 10 – 12 US$/ SQ. MTR
Top Side: 12-13 US$ /SQ.MTR
Spot Blasting: 120% OF ABOVE

Painting

Touch Up: 0.54 - 0.7 US$/ SQ.MTR
Vertical Side: 0.69- 0.8 US$/ SQ.MTR
Top Side: 0.85 -1.2 US$/ SQ.MTR



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HULL ROUGHNESS

Hull Roughness

Ship's hull roughness is an important factor that indicates the increase of vessel drag and hull friction, which directly affects the ship's speed and fuel consumption of the main engine. Hull roughness is measured from time to time, mainly during dry docking of the ship.

Hull roughness can be divided in to two factors –

1. Physical
2. Biological

Physical Factors:

- Macro Physical: Mainly occurs due to weld quality of hull, hull plate waviness, plate lapse and corrosion/mechanical damage

- Micro Physical: Mainly occurs due to minor corrosion of hull, wrong applied coating, or due to problem in the hull steel profile

Hull Roughness

Biological Factors:

- Macro Biological Factor: Comes into play due to weed and animal fouling

- Micro Biological Factor: Occurs due to algae and slime

<u>Two Major Factors of Hull Roughness:</u>

1. **Fouling:** Sea is teeming with marine life having different types of fishes, animals and organisms, some of which can only be seen with the aid of a microscope. Fouling is the growth of marine plants/organisms on the ship structure in contact with the sea water.

   Larvae of some organisms such as mussels, sponge, sea anemones, barnacles and weeds get attached to a hard surface when in reproduction phase. When these larvae “metamorphoses” into an adult, fouling takes place. Similarly in plant spores, sea weed appears smaller in size at initial

Hull Roughness

stages but grow steadily if left unattended. Once settled, the adhesion of this marine organisms is permanent and subsequent killing of the adult will not influence its adhesion to the substrate. Occurrence of ship's hull fouling varies with the time of the year, geographical locality, presence of currents and water depth.

of the hull where current re-enters are said to be cathodic. Hull corrosion occurs in the areas that are anodic.

There are numerous significant parameters that govern the corrosion rate and they depend on the material (composition, surface quality, metallurgical state etc.), environment (chemical composition, in particular pH and redox potential, contaminants, etc.) and conditions at the interface (fluid flow, temperature etc.).

Important Reasons For Ship's Hull Corrosion:

- Due to abrasion
- Due to contact damage, exposing the bare metal
- Due to scraping of paint, exposing the bare metal

Hull Roughness

- Due to non-working of hull anode

- Due to non-working of Impressed Current Cathodic Protection

- Due to wrong setting of Impressed Current Cathodic Protection

- Due to incorrect paint application technique

- Due to use of poor quality of paint

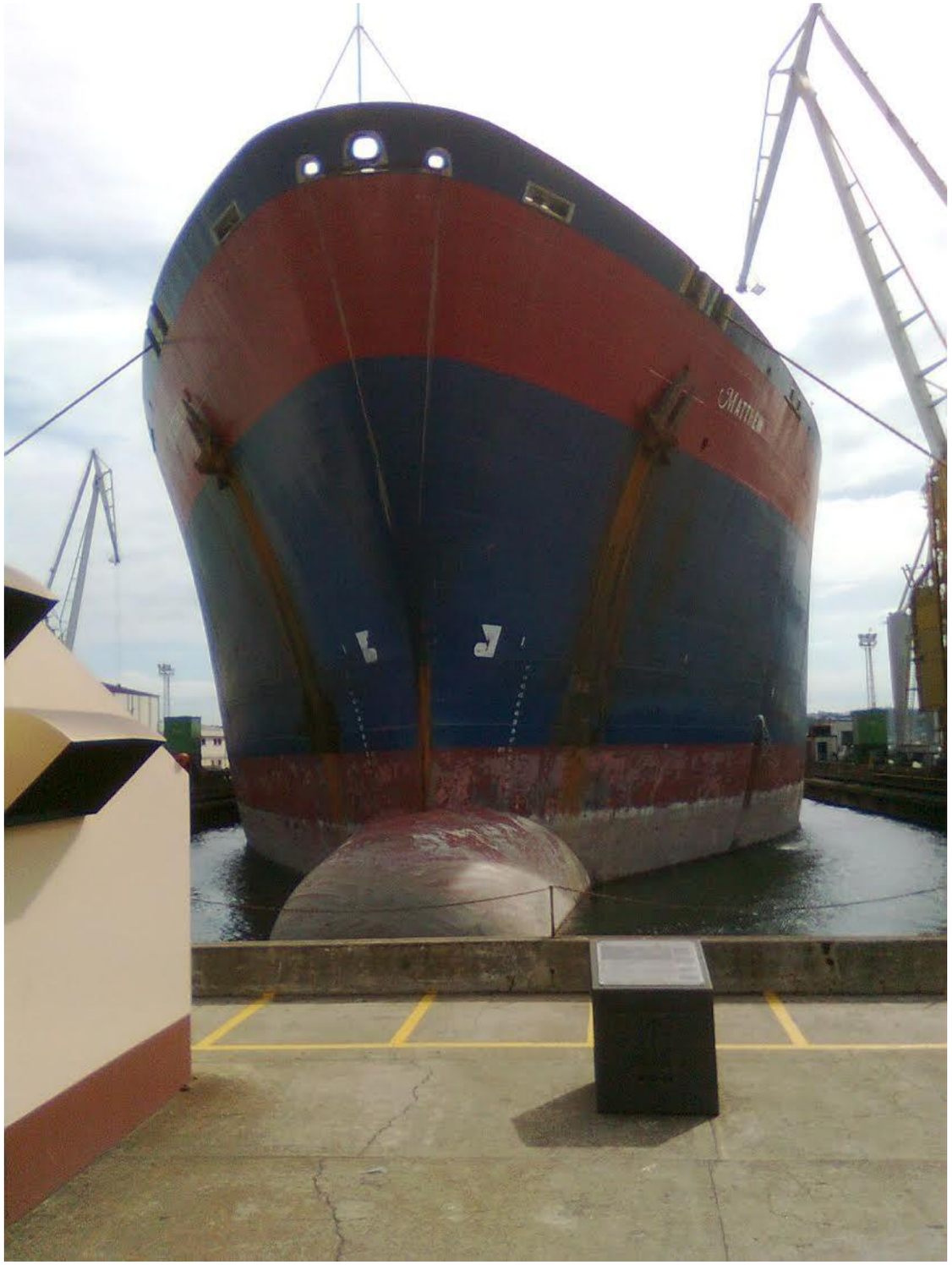


Image Credit: Alfonso Pardo

Measuring Hull Roughness

Hull roughness of the ship can be determined by a tool known as hull roughness analyzer or similar instrument for those ships, which are not coated with silicon based foul release paint coating.

If the ship's hull is coated with silicon based paint, speed trails are carried out to determine the hull roughness, which gives changes in the performance and speed of the ship. A Hull Roughness Analyzer (HRA) consists of a portable micro-processor with a digital printout and display unit.

Hull Roughness

A computer is connected to the hand held carriage having a stylus measuring head.

The stylus head is moved around the hull surface to measure and record the hull roughness profile. The short wave roughness is the diameter of the stylus tip. The long wave cut-off is set at 50 mm.

Working of Hull Roughness Analyzer

One traverse of the head at any point on the hull will collect information from 10 samples having length of 50 mm.

For each 50 mm sample, the micro processor will assess the mean gradient through the peaks and valleys to give highest peak to lowest valley measurement for that sample. This measurement is known as **Rt (50)**.

Hull Roughness

The roughness check covers approximately 100 selected locations, which must include bow, stern, mid-ship, and boot topping area (area between load line and ballast water line).

A number of traverses for stylus will give ‘n’ readings, hence the Mean Hull Roughness (M.H.R) at that station is the average of
Rt (50) i.e.

$$\mathbf{M.H.R = \sum Rt(50)/ n}$$

There will be ‘m’ stations around the hull of the ship. Hence, Average Hull Roughness (AHR) will be the average of Mean Hull Roughness i.e.

$$\mathbf{A.H.R= \sum M.H.R/ m}$$

When to Analyze the Ship’s Hull?

- Before launching a new ship, the hull surface is checked which becomes

Hull Roughness

the reference value of the ship

- When the ship comes in the dry dock and before the maintenance process is started on the hull. This gives the deterioration value of the hull

- Before undocking to measure or compare the hull roughness once the maintenance procedure is completed

Typical roughness or A.H.R of a new ship is approximately 120 microns.

Due to fouling and deterioration, an 8 year old ship will have A.H.R in the range of 300-400 microns.

Hull Roughness

Main Causes of Hull Roughness:

- Poor Initial surface condition of the steel plates

- Rough coating surface caused by wrong application techniques

- Rusting and corrosion of the hull

- Fouling of the hull due to marine growth and barnacles

- Poor quality of the hull paint

- Improper maintenance/ use of ICCP

Points for Maintaining a Smooth Hull

- Using current protection method for ship's hull
- Attaching sacrificial anode for ship's hull
- Using good quality corrosion protection paint
- Use of long lasting anti-fouling treatment
- Proper surface preparation before paint application
- Correct procedure for application of paints

4

TYPES OF PAINTS

Types of Paints

Hull painting is one of the most expensive dry dock operations that requires series of sub-operations. Ship paints come in different varieties and must follow the regulations laid down by the “International Maritime Organization” for safe guarding of the marine environment.

Ship comprises of areas made of various materials, which require different types of paints, hence the selection of paint will depends upon the surface, application method, approved costing and the environment that the area is subjected to.

Types of Paints

The ship paints mainly consists of :

- Solids
- Pigments
- Binder
- Extenders/ Fillers
- Solvents

Before ordering paints for ships, it is important for the ship superintendent and onboard ship management to check the previous dry dock survey report and paint scheme.

Different Types of Paints:

Types of paints used on ships can be broadly categorized into:

1. Conventional Paints:

- Bituminous paints: Based on Asphalt, Bitumen or Coal- Tar pitch and solvent, which is physically drying

- Alkyd resin paints: Based on drying oil, for e.g. linseed oil, castor oil, fish oil

2. Advanced Paints:

- Chlorinated Rubber: Physically drying (which mainly involves solvent evaporation, without any external application)

Types of Paints

- Vinyl Tar: Physically drying
- Epoxy/ Epoxy Tar: Chemical curing required
- Polyurethane: Chemical curing required
- Zinc Silicate

There are several reputed paint companies in the market which provides paints for marine applications. The selection of paint company will mainly depend on the geographical location of the dry dock assigned to the ship, approved budget and most importantly – type of ship and suggested type of paint for the ship's hull.

Paint Characteristics

Compositions of paints, their applications, properties and advantages/ disadvantages.

Alkyd Paint:

- This paint is air drying at moderate temperature
- It can be thinned with white spirit
- It can be applied on top of other paint
- Peels on glossy/ hardened alkyd paint
- Non-resistant to chemicals

Types of Paints

- It is a strong solvent

- The drying time is lesser than that of old type oil paint

- It is easy to apply and no special treatment is required

Application:
Everywhere above waterline e.g. superstructure, deck and engine room

Advantages:

- Good for application
- Single component
- Good flowing property
- Good weather resistance
- Good wetting properties
- Cheap

Disadvantages:

- Poor chemical resistance (alkaline)
- Poor water resistance
- Limited resistance of solvents
- Difficult when recoating
- Limited film thickness/coat

Types of Paints

Chlorinated Rubber:

- Made up of one component
- It can be physically dried and does not depend on temperature
- Requires special property thinner
- Special precaution to be taken while over-coating on other paint due to strong solvent
- It has low solid content
- It is easy to overcoat with no peeling off
- It has rapid drying property
- The surface requires good pre-treatment i.e. sand blasting

Types of Paints

Application:
Mostly used for painting bottom, boot top, topside areas of the deck

Advantages:

- Independent to application of temperature
- Low permeability
- Re-soluble characteristics

Disadvantages:

- Poor resistance to solvents
- Low content of solid percentage by volume
- Poor wetting properties
- Thermoplastic in nature

Bituminous Paint:

- Physically drying characteristic

- The drying property depends more on ventilation than temperature

- Can be applied on top of other paints

Types of Paints

- It has high solid content
- It is easy to recoat with no peeling effect
- It has good resistance against water and moisture
- It has good wetting property
- No special surface pre-treatment is required
- It is based on asphalt, bitumen or coal tar pitch
- When applied over other paints, it will bleed through the paint coat

Application:

It is used as primer pigmented with aluminum, for painting of ballast tanks and chain locker.

Types of Paints

Vinyl Paint:

- Physically drying and doesn't depend on temperature
- It has a special solvent requirement
- Requires precaution when coating it over other types of paints
- Has low solid content with short drying period
- It is easy to recoat with no peeling effect
- It requires good surface pre-treatment
- Surface moisture during painting will lead to adhesion failure

Application:
Used for painting boot topping, shipside and superstructure

Vinyl Tar Paint:

- It is a combination of sophisticated and conventional paints
- Other properties are similar to vinyl paint
- Physically drying and doesn’t depend on temperature
- It has a special solvent requirement
- It requires fairly good pretreatment
- It has very good resistance against water
- Good resistance to moisture, mechanical strain and crude oil

Application:
Underwater primer, protective coating for combined/ ballast tanks, cargo holds, car pontoons.

Types of Paints

Advantages:

- High content of solid percentage by volume
- More waterproof than vinyl paint
- Better wetting properties
- Cheaper

Disadvantages:

- Bleeding property

Polyurethane paint:

- It is a sophisticated combination of conventional and advanced type of paints

- It is temperature dependent

- It has a special solvent requirement

- It has average solid content

Types of Paints

- Very good surface pre-treatment is required

- It is a resistive to mechanical strain and weather

Application:
Used on superstructures if long painting intervals are required and is also used for painting engine rooms.

Epoxy Paint:

- Sophisticated two component paint which requires chemical curing

- Drying of this paint is temperature dependent

- It cannot be over coated on other paints

- Repainting is difficult due to inter-coat adhesion problems

- Requires strict adherence and curing time schedule

Types of Paints

- High solid content

- Has good resistance against water, moisture, chemical solvent and mechanical strain

Application:
It is used as protective tank coatings and on hull under special conditions

Advantages:

- Very good durability factor
- Chemical reaction makes it important to breakdown paint with solvent
- High density
- Mechanically strong

Disadvantages:

- Difficult to repaint as it requires roughening by sand blasting
- It chalks in sunlight
- Surface preparation of Sa 2.5/3.0
- Curing is difficult if temperature < 10 Deg. C
- It is expansive

Epoxy Tar Paint:

- It is a combination of epoxy and tar
- Sophisticated two component paint which requires chemical curing
- Drying of this paint is temperature dependent
- Cannot be over coated on other paints
- Dissolution of previous coat is difficult
- Repainting is difficult due to inter-coat adhesion problems
- Requires strict adherence and curing time schedule
- Requires a good surface pre-treatment
- High solid content

Types of Paints

- Chalks when exposed to sunlight

- Better wetting properties than epoxy paint

- Has very high resistance against water, moisture, chemical solvent and mechanical strain

Application:
It is used as underwater primer, protective tank coatings for crude oil and ballast tanks.

Advantages:

- It is more flexible to use
- Low cost
- High water resistance
- Better penetration

Dis-advantages:

- Dark color
- Sensitive to application of temperature
- It is a 2-pack product
- It requires re-coating intervals
- It has bleeding properties

Types of Paints

Zinc Silicate:

- Sophisticated two component paint
- Two components: Zinc duct + Binder
- It requires chemical curing
- It can be applied on steel only when the surface is blast cleaned to Sa 2.5
- It is resistive to mechanical stress
- It is resistive to heat and organic solvents

Application:
Used to coat solvent tanks (chemical tankers), offshore construction, car pontoons and other structures exposed to great mechanical stress.

Types of Paints

Advantages:

- Outstanding corrosion protection property
- Cathodic protection of zinc in the paint
- Shut-off effect of zinc salts
- Very good hardness
- Excellent heat resistance

Disadvantages

- Very Expensive
- Requires good surface preparation
- Require sophisticated application procedure

5

SURFACE PREPARATION

marine insight

Surface Preparation

Surface preparation of the ship's hull in dry dock is an integral part of the painting operation. Proper surface preparation is essential for the long life and effectiveness of the paint coating system.

Surface Preparation

The quality and extent to which a hull surface is made clean before the coating depends on the following factors:

- Expected performance of the coating
- The paint manufacturer's recommendations
- The time available for the job
- The relative cost of the various surface preparation methods available
- Access to the area to be prepared
- The condition of the steel prior to surface preparation
- Skill and knowledge of painter/ spray operator

Surface Preparation

Two important objectives of hull surface preparation are:

1. To remove loose materials on the outer hull surface such as scale, dirt, oxide film, grease etc. This is done to ensure paint adheres properly to the hull surface

2. To increase the surface area of the substrate by increasing the roughness and anchor pattern of the hull surface

Precautions Before Hull Surface Preparation:

- Ensure all engine and deck personnel are informed about the surface preparation operation

- All hull openings are covered with temporary covers

- No paint drum is kept outside in open condition else the blast dust will

contaminate the paint itself

- All anodes attached to the hull are removed or protected

- The engine room and accommodation ventilation systems are shut-off or minimized to ensure minimum dust is sucked inside by the fans

- All workers involved in the surface preparation operation must don safety gears

- All ship's crew to use face mask when out on deck

- The method for surface preparation (sand blasting, hydro-blasting etc.) is discussed and approved by the paint inspector

- Any water seepage/ leakage from tank drain is stopped

Different Methods for Surface Preparation:

Surface preparation is an import process which influences paint performance. Different types of surface preparation methods are used to clean the hull from dust, old coatings, contaminants and rust.

The surface of the ship's hull must be completely free from all contaminants that can impair performance and prevent good adhesion of the paint system. Needless to say, the quality of the surface preparation is directly related to the lifetime of the paint system.

Ship personnel must take all necessary precautions to prevent accidents during this process. The shipyard should determine skilled worker, equipment, and materials that are required for the surface preparation and conduct a hazard assessment before commencing the process.

Surface Preparation

Following are the important and most used methods for hull surface preparation:

1. **Abrasive blasting:** This is the most common method used to clean and prepare the surface for painting and coating. Different abrasive particles with high pressure are used to clean the surface. Some of the most common types are:

- Fine sand
- Coarse sand
- Iron Grit
- Iron shot

Iron grit and iron shot are the commonly used abrasive particles in dry dock.

With the help of compressed air pressurized at 7 kg/cm, grit is shot on ship's plate through special nozzle from a distance of **20-40 cm.**

The grit impact removes all loose rust or paint and slightly roughens the surface, which helps in holding the new coating.

2. Spot blasting: An abrasive, localized preparation process commonly used on the outside of ship's hull during repair and maintenance work, when patches of localized corrosion have occurred.

3. Sweep blasting: In this method, a jet of abrasive is swept across the surface of the steel rather than focusing on one area for any period of time. Its effectiveness depends on the type and particle size of the abrasive used, the condition of the surface and the skill of the workers.

4. Hydro blasting: Hydro blasting (also known as hydro jetting, water blasting and water jetting) is an environment friendly method to clean

ship's surface. The equipment used in this method is known as hydro-blaster, which applies high pressure (≥1000 bar) of water jet to clean the surface. Visually the surfaces often appear dull or mottled after the initial cleaning is completed.

5. Hand/ Power tool cleaning: In this method, the operator cleans the surface using manual or power operated tools without the aid of pressurized media. It is usually done on those areas where pressurized blasting cannot be carried out. The most commonly used hand/ power tools are :

- Hand wire brush
- Hand scrappers
- Disc sander
- Electrical wire brushes

Nowadays hand chipping is not commonly used as it dents/ damages surface, increasing the hull roughness.

Degree/ Standard of Blast Cleaning:

Most commonly used standard to check the blast cleaning of ship's plate is defined by the Swedish Standards Institute (SSI) with the following grades:

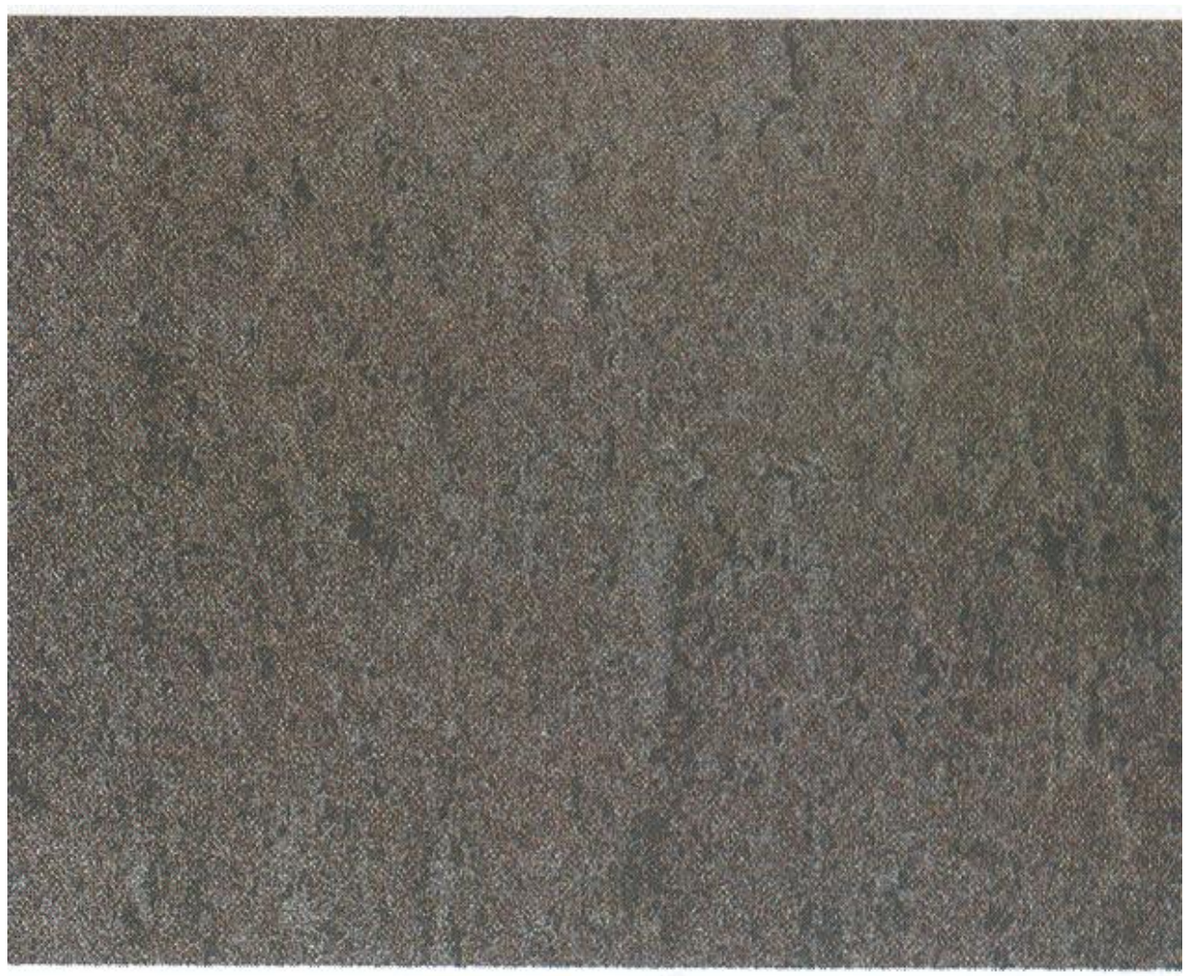
- Sa 1
- Sa 2
- Sa 2.5
- Sa 3

These grades are described/ defined along with sample photographs published by SSI which are used for comparison to judge the degree of blasting/cleaning.

Most of the painting schemes recommends Sa 2.5 grade.

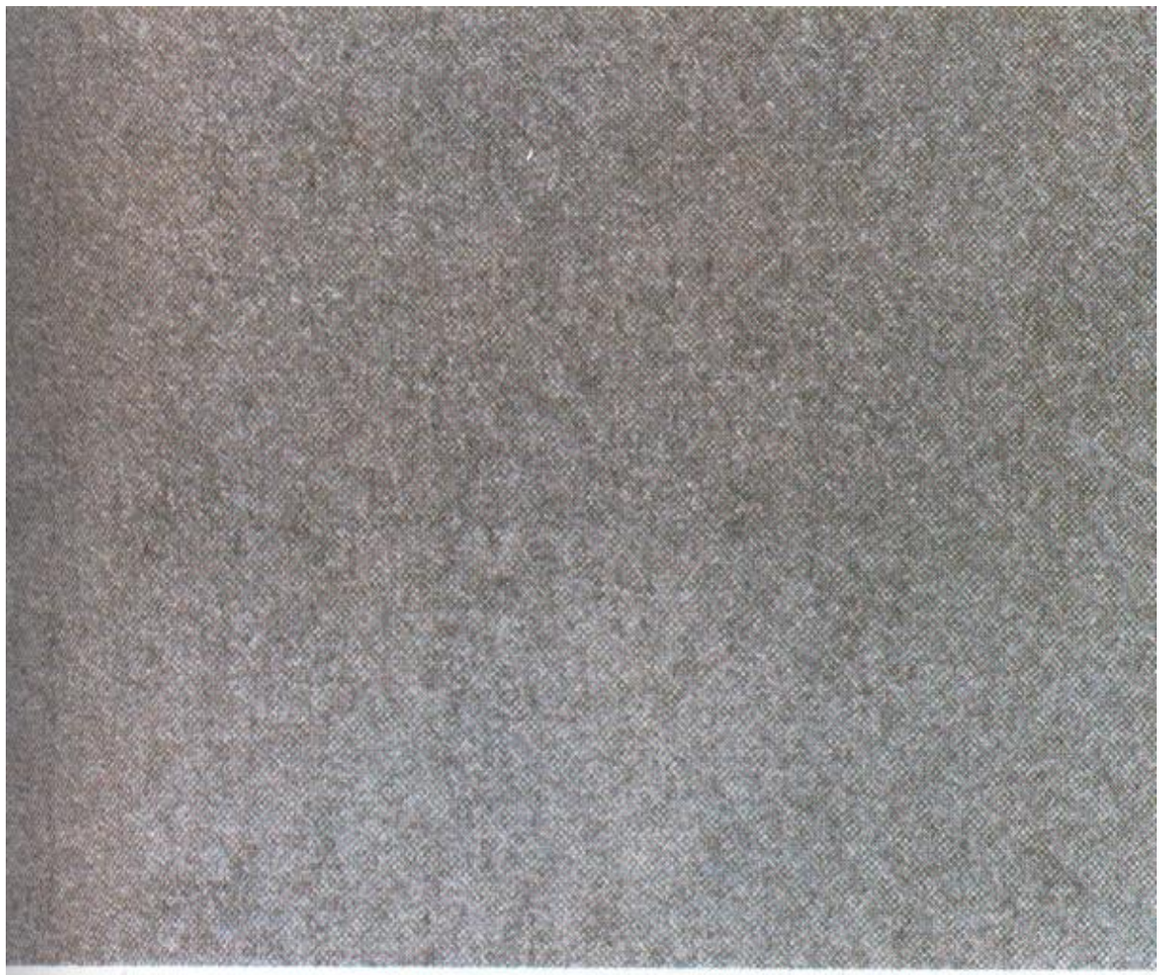
PICTORIAL DESCRIPTION

Sa 1

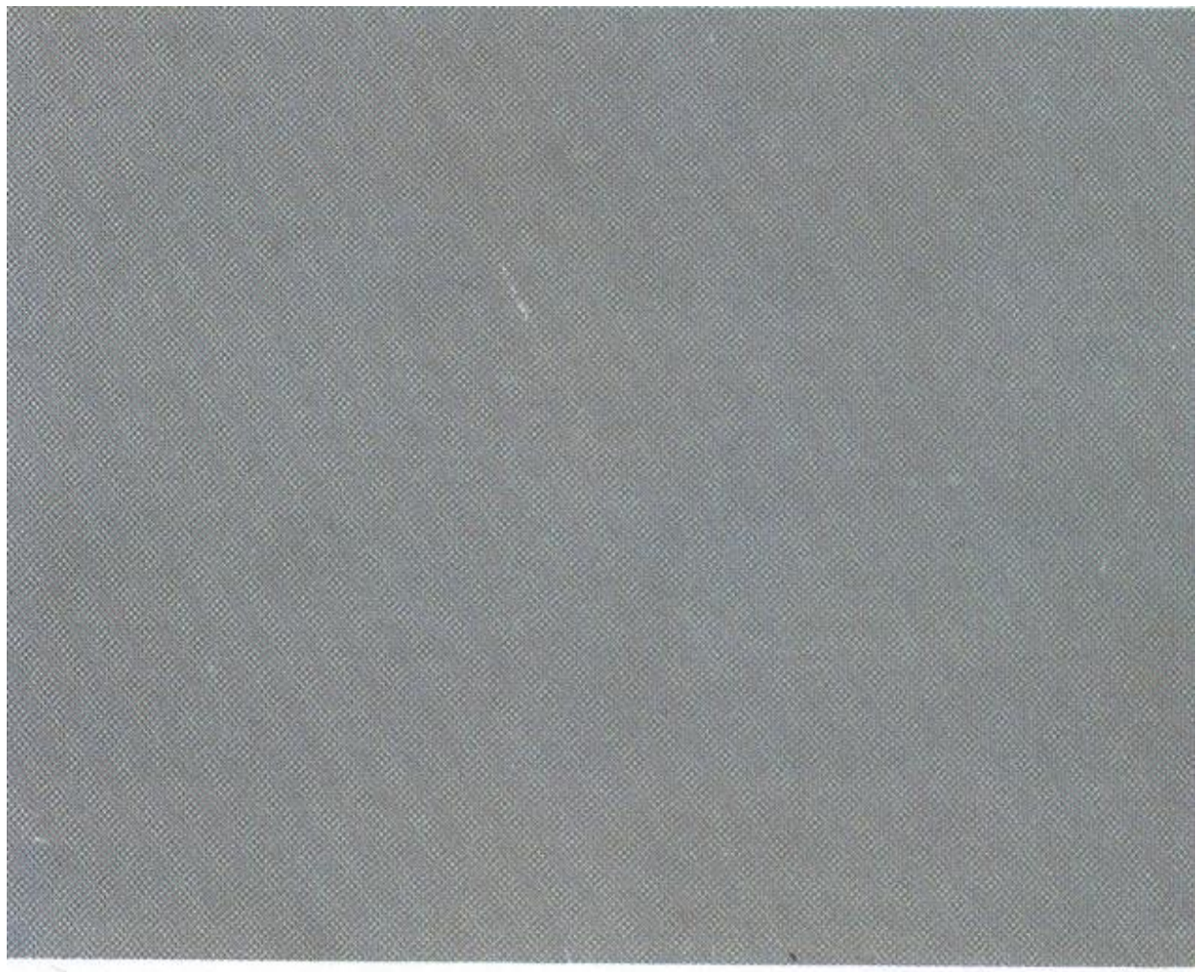


Sa 2

PICTORIAL DESCRIPTION



Sa 2 1/2



Sa 3

6

PAINT APPLICATION

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Paint Application

It is important for superintendent and management officers to know about the precautions and painting schemes once the ship's hull is ready to get painted.

The painting of the ship is usually done by a shore company, which is in contract with the ship management company or the owner, to ensure efficient and timely completion of the paint process.

Paint Contract:

During the ship's life cycle, paint is considered to be the 2nd most expensive consumable item on the ship. Normally a long term contract is signed with a reputed international paint manufacturer for the fleet of ships. This also gives discount to the ship owner/ manager in the total paint costs.

The paint manufacturers will recommend a painting scheme depending on the type and different parts of the ship. They will also provide a painting manual/ painting data sheet to each contracted ship.

Paint Scheme/ Data Sheet:

A paint data sheet is a record which carries all the important information regarding the property and application requirement of the paint. It comprises of:

- Trade name and type of paint
- Recommended method of application
- Time Interval required for over-coating
- Time required for drying
- Required thickness of dry and wet film of the paint
- Number of coats of each type of paint to be applied

Paint Application

- Solid content (volume %) of the paint

- Storage requirement, flash point and color of the paint

- Cleaning and thinning solvent mixing quantity

Paint Application:

The paint application on the ship's hull, normally carried out in the dry dock, is done by pressurized spray and not by brush or roller.

There are two types of spray paintings:

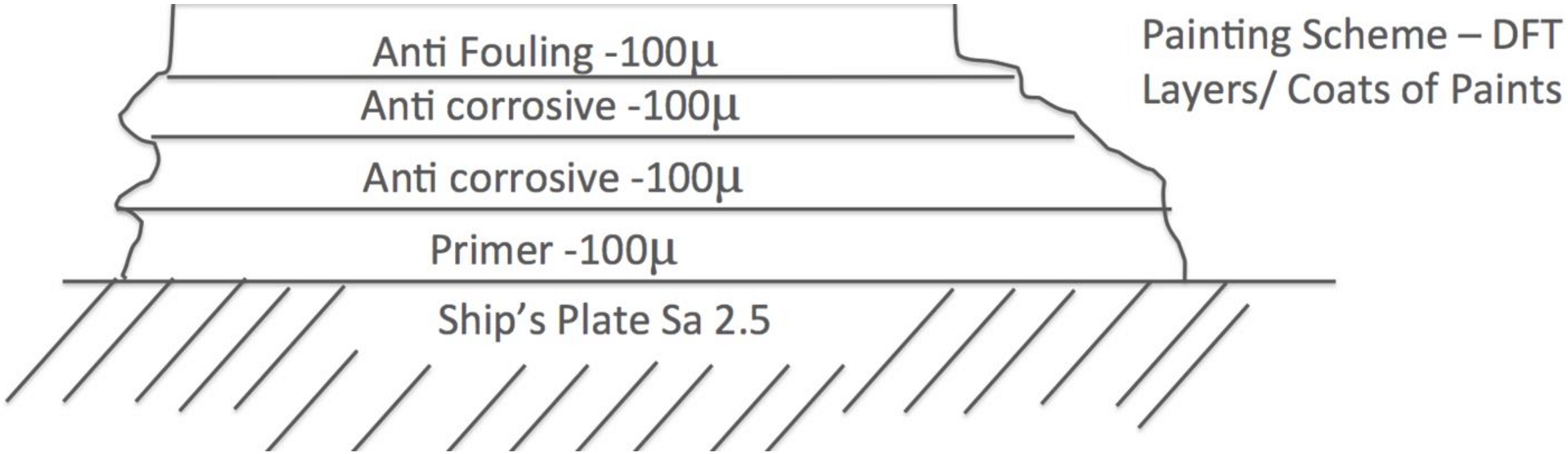
1. **Air spray**: In this method, paint is mixed with medium pressure air (7-10 kg/ sq. cm) which is then sprayed through nozzle of suitable size.

2. **Solid Injection (Airless spray)** : In this system, the paint is injected at

high pressure (100 – 450 kg/ sq. cm) using high pressure (h.p) machinery spray system without mixing any thinner or air. Compressed air is used only to operate high pressure paint injection pump.

Layers/ Coats of Paint:

Painting scheme specifies the number of coats of each type of paint to be applied on bare steel after blast cleaning. A general overview of the painting scheme is shown in the diagram below:



Precaution to Take Prior Paint Application

Painting of hull is an extensive operation which requires several precautions to be taken before commencing the process.

Following are the points to be considered before starting paint operation:

- All anodes to be covered
- All hull openings to be covered
- Corroded areas to be cleaned by grit blasting
- Surface to be washed down with fresh water blown by compressed air
- Hull surface to be completely cleaned and contaminants such as salt, dust, rust, scale, grease etc. to be removed

Paint Application

- Weather to be checked prior painting operation

- The staging for the operator to be evenly rigged and all safety precautions are taken

- The paint data sheet to be checked and all precautions listed in the sheet to be followed

7

PAINT THICKNESS

Paint Thickness

The painting scheme/ data sheet provided by the paint company gives details of recommended paint film thickness for each coat.

Paint Thickness

The thickness of the layer or coat of the paint applied can be measured as :

1. When Paint is dry: This measurement is denoted as Dry Film Thickness (DFT)

1. When Paint is still wet: This is known as Wet Film Thickness (WFT)

Relationship Between DFT and WFT:

Paint data sheet shows the solid content of the paint along with other details. For e.g. if solid content is 40%, this means the content of solvents in the paint is 60%.

Once the paint is dry after applying the paint to the ship's surface, the solvent content of the paint becomes "0". Hence the relationship between paint DFT and WFT will be:

DFT = WFT x (% of solid content)

How to Measure DFT?

The dry film thickness is normally measured by electronic gadget based on the ultrasound principle, which indicates paint layer in microns. This device will be accurate only on very smooth surface.

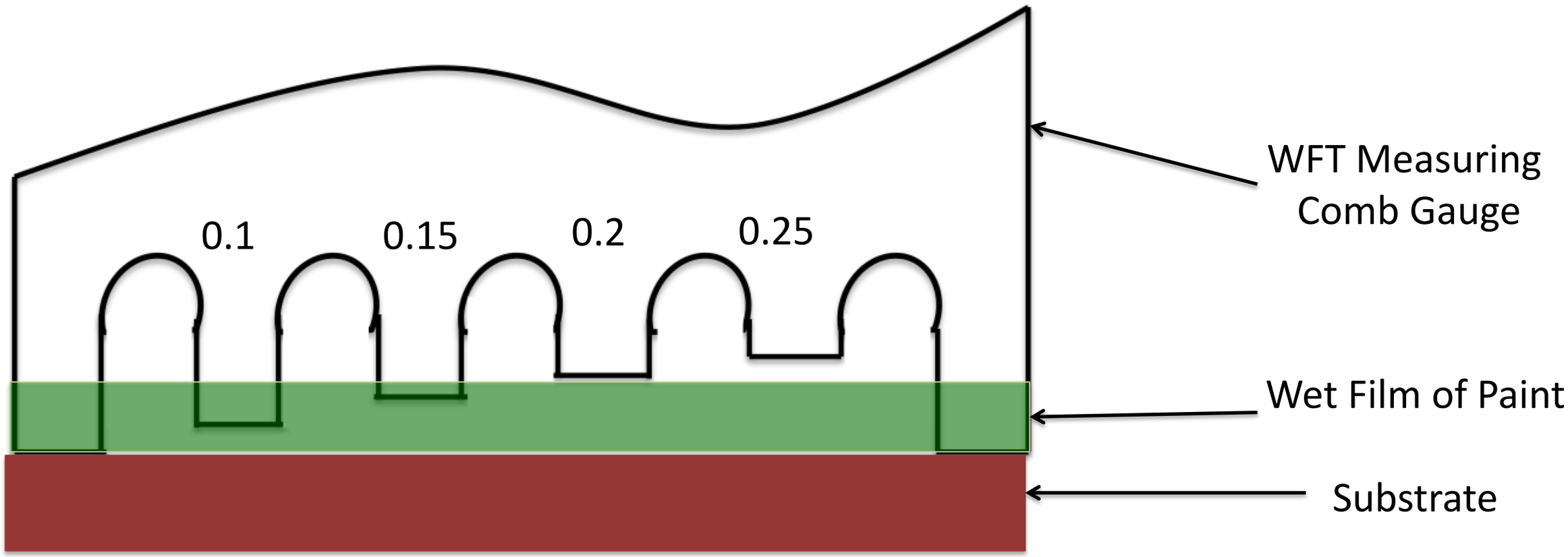
How to Measure WFT?

Wet Film Thickness is measured by using a toothed measuring gauge, which comprises of different depths on its cylindrical body.

The gauge (also know as paint film thickness comb) is pressed on freshly applied paint and the depth is indicated in microns. The paint inspector is responsible to check the paint thickness but it is equally important for the ship superintendent or the responsible ship officer to randomly check the paint film thickness at least once during the painting operation to ensure all the coats are as per the manufacturers paint document.

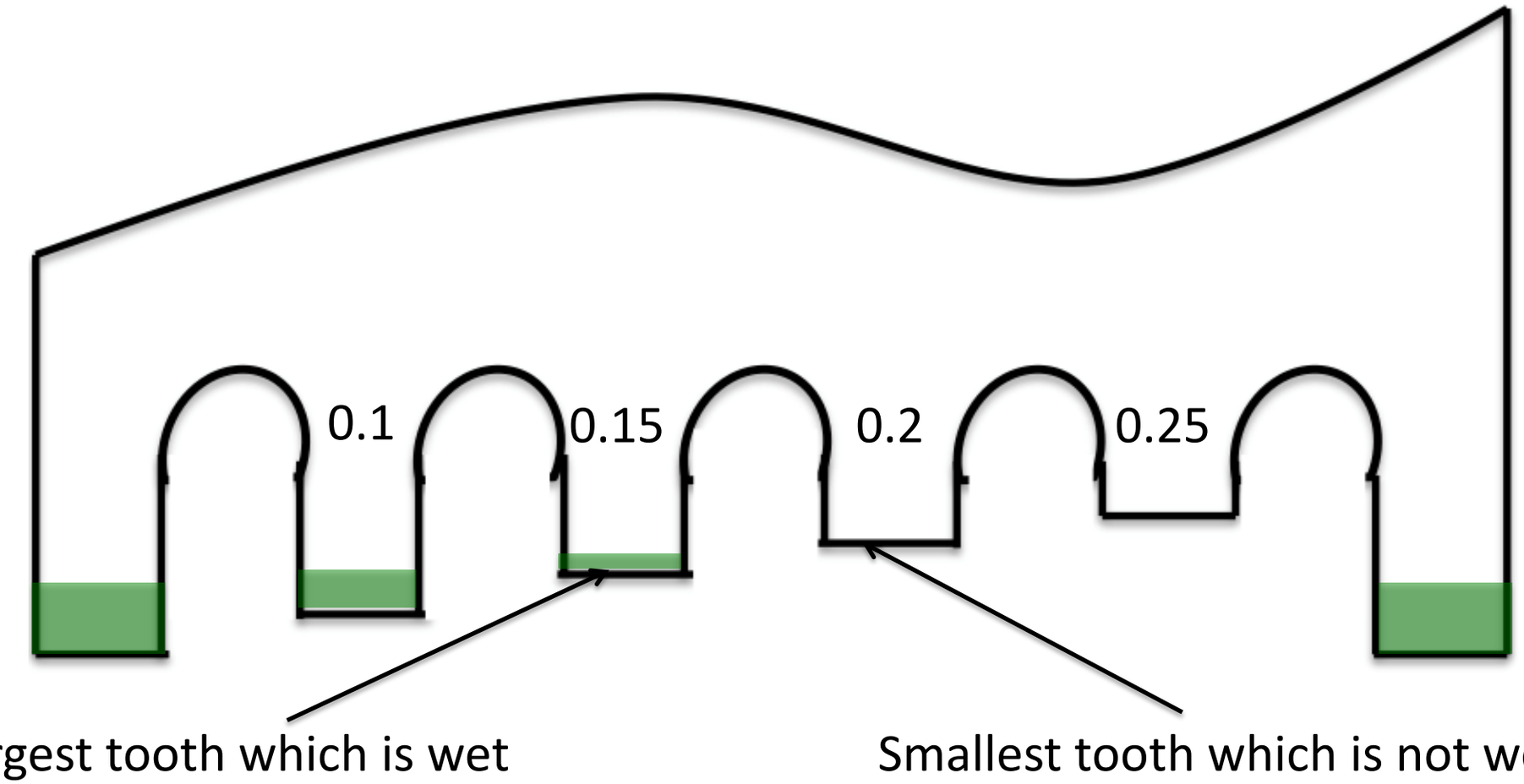
Note: It has been found that not many seafarers have seen this gauge and neither they have the knowledge on how to measure the thickness using the gauge.

How to Use Film Thickness Comb?



The Gauge teeth/ notch are of different length (measured in mm or inches). The gauge is inserted perpendicular to the coated surface and a firm contact with the substrate is made to get the correct reading.

Paint Thickness



After removing the gauge from the wet paint, it can be clearly seen that the paint impressions are not on all notches/teeth. Note down the largest tooth which has got the paint impression and the smallest tooth which is not wet. Here the longest notch with paint impression is 0.15 mm and shortest notch without any impression is 0.2 mm. Hence, the wet paint thickness is between 0.15 to 0.2 mm.

8

DRYING & CURING TIME

Drying and Curing Time

The paint applied on the ship's surface needs idle time to get dried or cured before the ship is put into operation or when additional coats are applied over the paint. This time interval is known as drying and curing time of the paint.

Difference between Drying and Curing Time:

Drying time of a paint is the time limit after which the surface can be used for normal work. In case of ship's hull, once the drying time is over, the ship can be taken into the water.

Curing time is the time interval required for the paint to get dried up before any other coating is applied to the existing paint layer. Normally the curing time is more than the drying time.

Important Factors:

- The drying and curing time depends on the surrounding temperature and are inversely related to it. As the temperature increases, the drying and curing

Drying and Curing Time

time will decrease. Most of the paints come with temperature limitation for application

- At temperature of below 5 °C, the curing of most paints such as epoxies slows down dramatically and for some paints it completely stops

- Similarly, with temperature above 30 °C, the drying and curing of paint will be rapid. Care should be taken to avoid dry spray caused by too rapid loss of solvent from paint droplets between the spray nozzle and the surface

- The drying and curing of paint will also depend on the dry film thickness of the paint

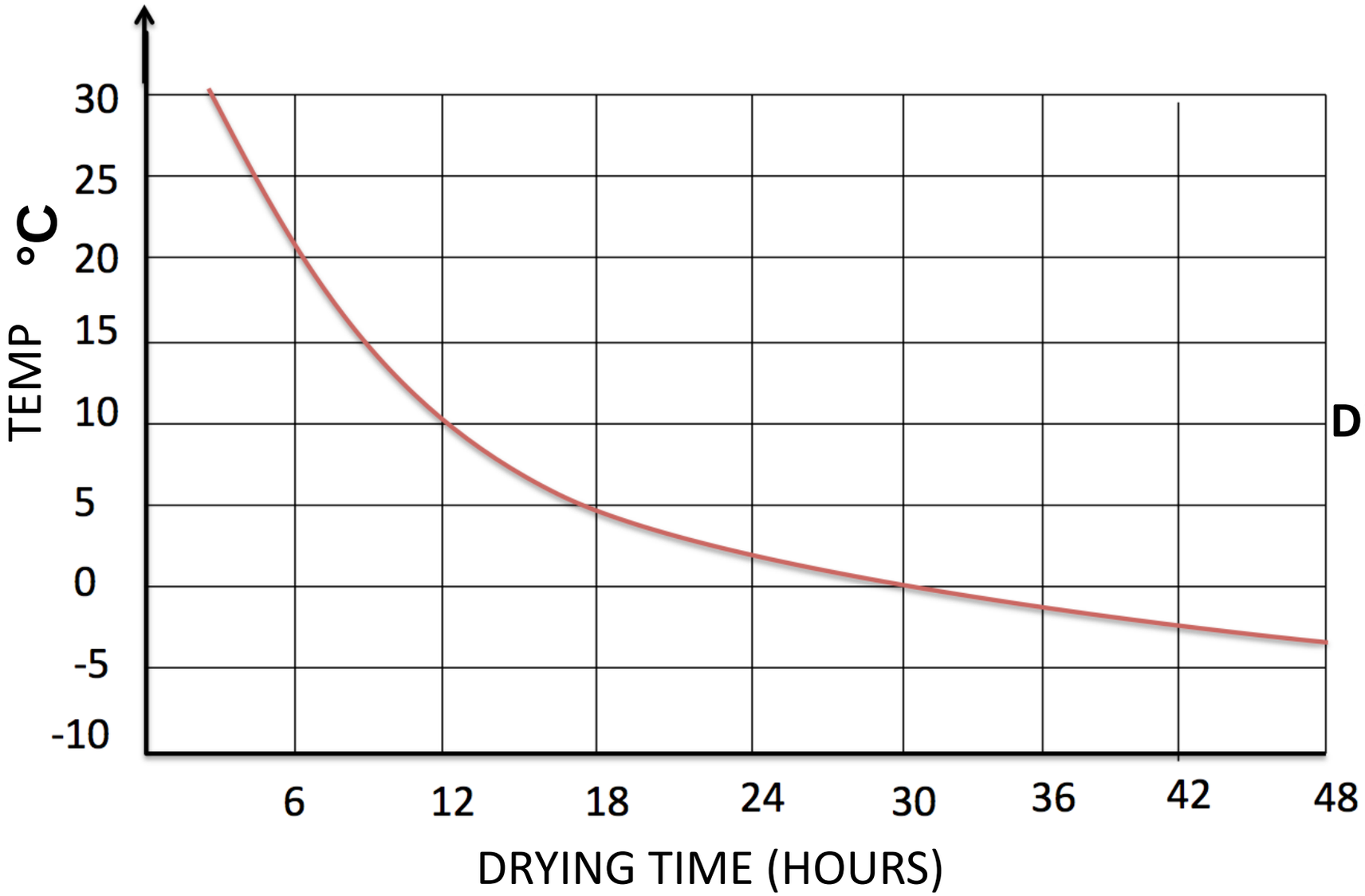
- Paint may be “touch dry” (surface of the paint is 100% dry) but must be fully cured and dried before next coat is applied

- The drying and curing time with respect to temperature is listed in the paint data sheet at specified DFT

Drying and Curing Time

Before following the drying and curing time interval, measure the DFT of the paint layer and confirm it is same as given in the data sheet

- Ensure the paint is fully cured else if over coated without curing, the lower layer which is still soft, will shift leading to uneven surface



DRYING TIME/ TEMPERATURE GRAPH

9

PAINT INSPECTION

It is very important to perform a pre and post paint inspection to ensure long efficient working life of the selected hull paint. For doing paint surveys, the paint companies can nominate their own paint inspector or shipping company/ management may nominate a paint inspector from a third party to ensure all the aspects of painting operations are checked and complied with.

Paint Inspector:

Normal practice in the dry dock is to appoint a paint inspector (representing the paint company), who checks and supervises the entire painting operation of the ship.

To derive full advantage of this highly experienced inspector, the ship superintendent and staff must cooperate with him/her and give all the help and assistance required by the inspector.

It is always advisable to appoint an inspector representing the paint company. As the paint inspector has to look after his customer i.e. the ship's interest,

Paint Inspection

he/she will not allow the paint operation to go wrong which can lead to pointing finger at the paint company.

PAINT INSPECTOR PERFORMING SHIP'S HULL INSPECTION

Important Checks To Be Made by Paint Inspector:

- Quality of blast cleaning
- Surface preparation of the paint area
- Correct mixing of paint
- Use of correct spray nozzles
- Use of correct spray painting technique
- The amount of paint applied (WFT)
- Adequate curing time is given before applying the next coat, considering important factors such as weather, ambient temperature etc.
- Check WFT of each coat of paint applied to the surface

Paint Inspection

- Correct drying time for the paint is followed

- Correct paint is used over right layer of paint

Paint Inspection

Additional Checks:

- Weather forecast is checked prior conducting painting operation
- Check and ensure there is no moisture on the surface. Paint and moisture never combines
- Painting to be carried out only in dry weather
- Check humidity and if it is > 85 %, stop working
- Check dew point of the atmosphere
- Ensure the temperature of the steel surface to be painted must be at least 3 deg. C above the dew point

10

HOW NOT TO PAINT SHIP'S HULL

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In spite of following procedures for efficient paint operation, there can be situations and mistakes during the surface preparation and painting of hull which may lead to time consuming additional operations or poor paint application quality.

When the ship is in dry dock for hull painting, it is very important for the paint inspector, superintendent, master and chief engineer to take a look at every small detail of preparation and planning for paint operation to avoid silly mistakes, which may later lead to major problems.

Following are few important pictorial illustrations of things to avoid for preventing coating failures and how NOT TO carry out ship's hull painting operation in the dry dock:

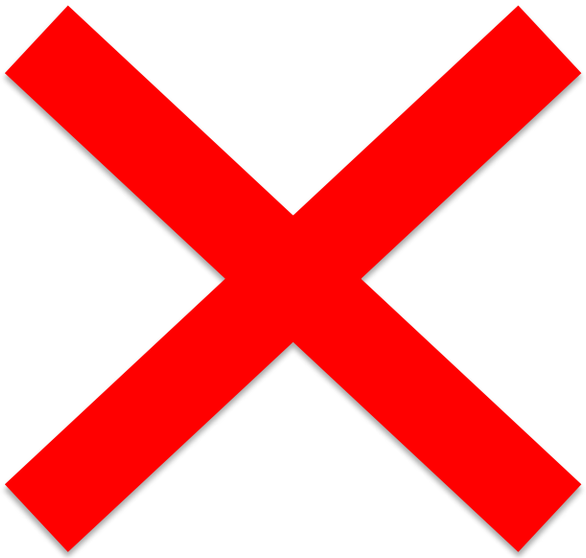
How Not to Paint Ship's Hull

If the water is continuously running out from the scupper in the ship's hull during blasting and surface cleaning operation, the grit dust will stick to the surface making it hard to clean the same at later stage.

Always use plug to stop any water leakages from the scupper.

How Not to Paint Ship's Hull

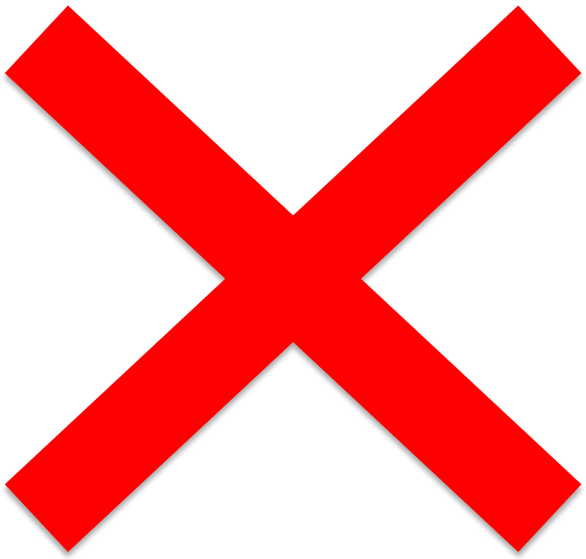
Ensure plugged scupper is not open till the paint has been dried completely else it will ruin the paint layer.



Remove anode before performing surface cleaning of hull.

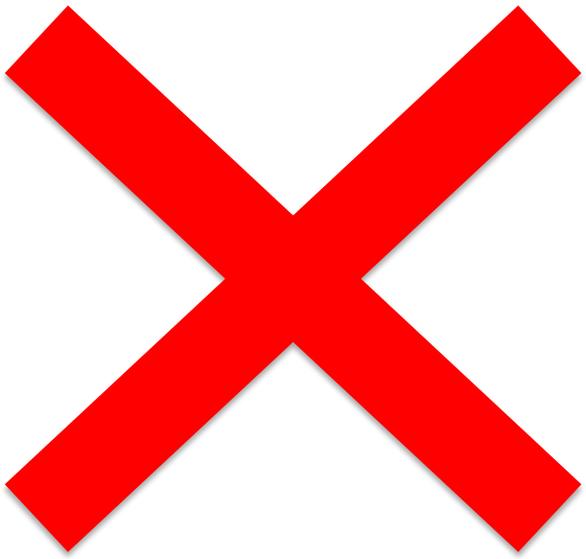
How Not to Paint Ship's Hull

Always check weather forecast to avoid rain ruining the hull paint.



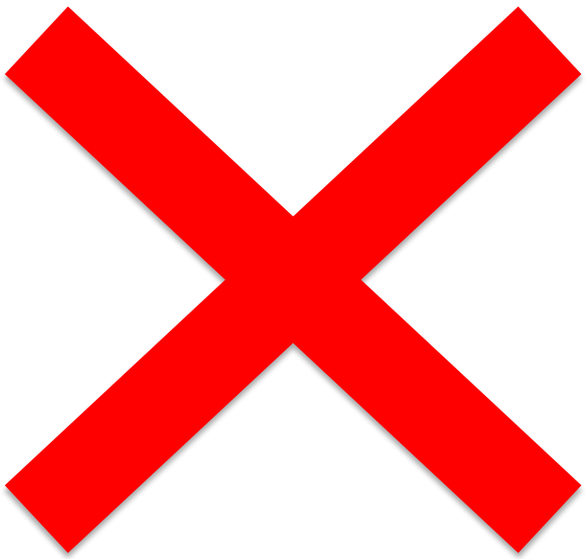
How Not to Paint Ship's Hull

In a multi-capacity dry dock, never paint hull if cleaning/blasting operation of adjacent vessel is underway.

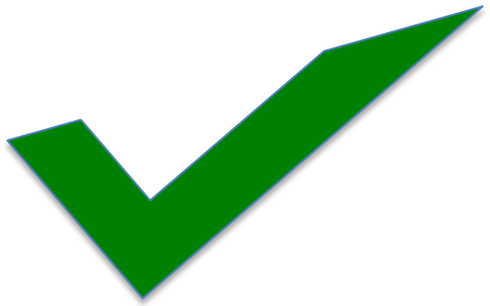


How Not to Paint Ship's Hull

Ensure the spray gun is not too long for the operator to prevent uneven painting of surface. It is always recommended to use elevated platform or crane.

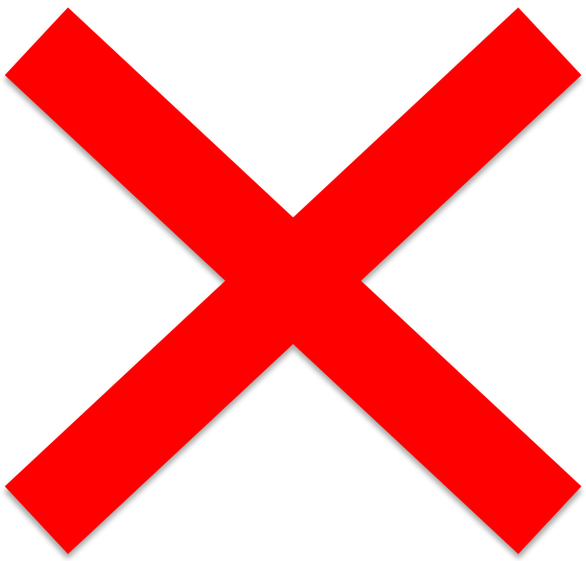


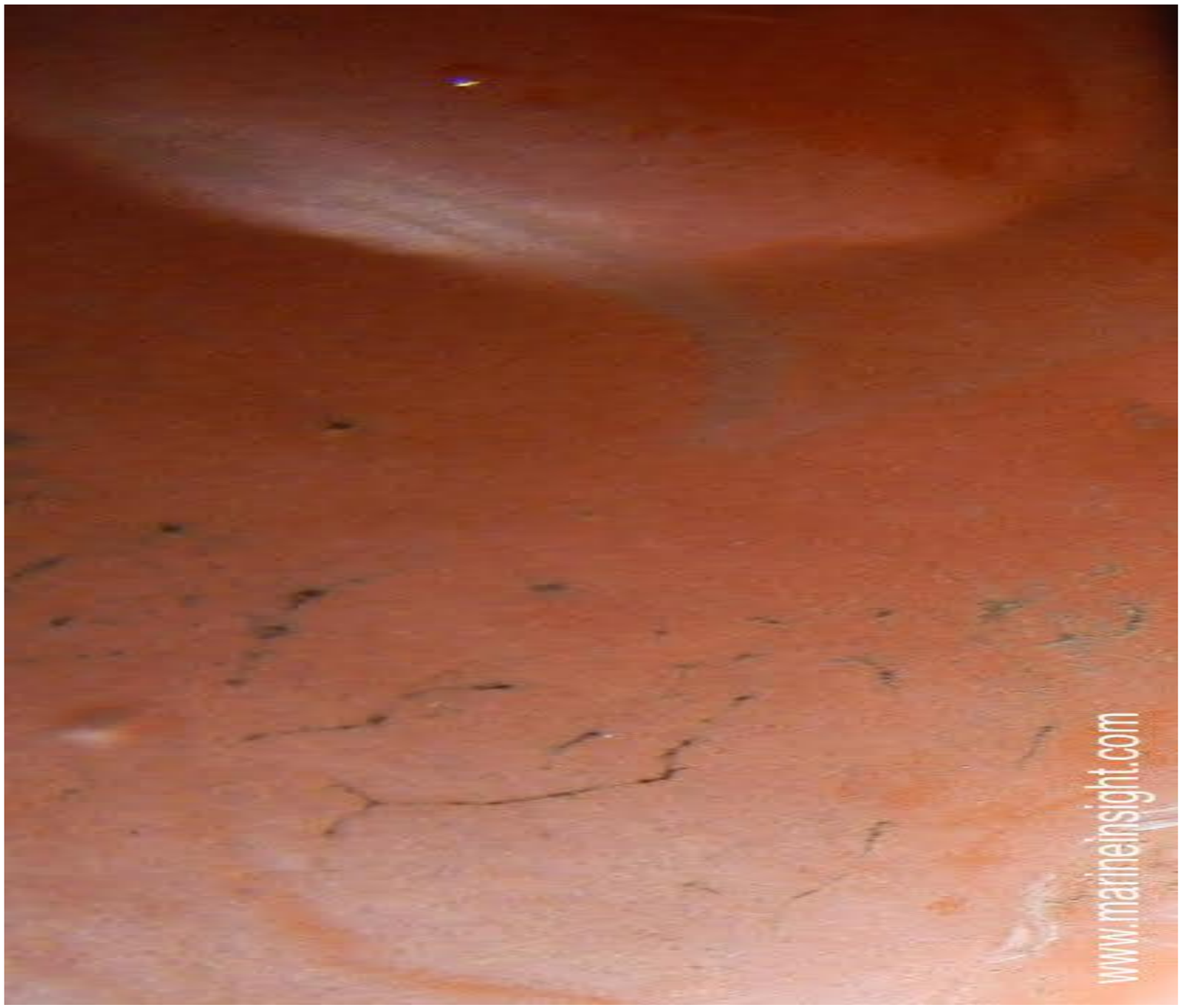
Correct spray angle and an appropriate distance from the paint surface using elevated crane/platform guarantees evenness of the paint application.



How Not to Paint Ship's Hull

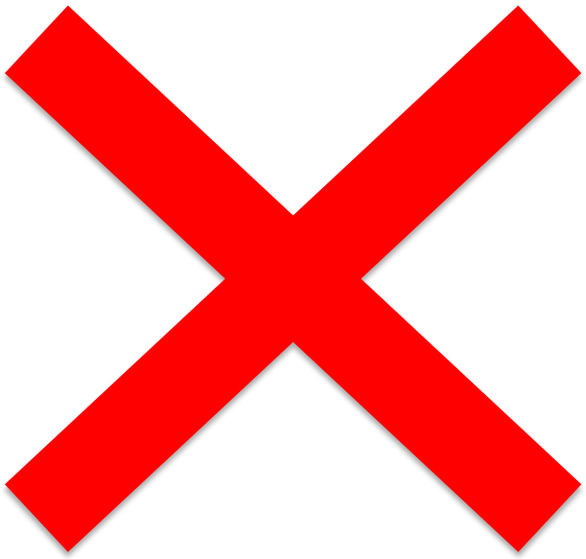
Ensure the anti-fouling coat applied is not too thick, which can causes sagging and increase in hull resistance.





How Not to Paint Ship's Hull

Ensure the anti-fouling coat has not been applied using wrong/ worn-out nozzle, which will roughen the surface and increases fuel consumption



11

RECORD KEEPING

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Record Keeping

"If it's not logged, It's not done". - This is the importance of paper work in all major shipping operations. As per the ISM code, all the important operations are to be logged and recorded in the ship's paper work system.

Records of dry dock operation are of real importance and are used for future references when the ship goes to the next dry dock, undergoes any major repair or experience any trouble.

Painting operation is the an important part of dry dock operation and logging the major aspect of this procedure is of shear importance. The ship personnel involved in the process are responsible for logging down the important paper work of painting operation but the ultimate responsibility lies with the master and chief Engineer of the ship. Ship superintendent must cross check the ongoing paper work and ensure nothing has been missed out from the records.

Record Keeping

Following are the things to be recorded/ logged:

- Type of work performed on the hull surface
- Maximum and minimum air temperature during painting operation
- Temperature of steel surface to be painted
- Percentage relative humidity during operation
- The dew point of the atmosphere
- Ventilation provided, if any
- Area of grit blasted
- Area of painted surface

Record Keeping

- Consumption of grit during hull preparation
- Consumption of paints
- Types of paints and their product number
- Minimum and maximum drying/curing time of the applied paint
- Control of dry film thickness
- General weather condition
- All irregularities and important points noted during the paint inspection

12

SUMMARY

Summary

Paint application on a ship's hull is an important job which requires utmost caution and precision. Considered to be the 2nd most expensive operation, hull painting of ship needs to be carried out with planning and professionalism.

Needless to say, even a small mistake can ruin the property of paint applied to the ship's bottom which will inversely effect the fuel efficiency of ship just out from the dry dock.

Since the hull painting procedure is always performed by shore workers, the ship representative (Superintendent/ master/ chief engineer and chief officer) must know the fine points involved in this operation to ensure maximum efficiency is achieved.

Summary

Summing up all the important points, which must be kept in mind from planning to finishing of the painting operation of ship's hull and ship's side:

- Inspect ship bottom and side with paint inspector and assess the condition to decide the scope of the job

- Study recommended paint scheme and inform all personnel who are involved in the painting operation

- On completion of blasting, area blasted to be washed down with fresh water to remove blast dust prior to paint application

- Empty ballast tanks to avoid condensation of the painted surface

- Check contractor's equipment: Paint mixers and mechanical stirrers which are mandatory for 2 pack systems

Summary

- Check ambient temperature

- Check relative humidity, which should not exceed 85%. Stop if this limit is exceeded

- Steel temperature should be at least 3 degree above the dew point of the atmosphere

- Check weather forecast for the time of paint application and drying of paint to avoid rain ruining the paint operation

- Check Wet Film Thickness (WFT) of each coat to ensure correct Dry Film Thickness (DFT)

- Ensure proper curing time is given for each coat of paint as specified in the paint scheme prior application of next coat

Summary

- Check correct amount of thinner is used to dilute the paint
- Ensure all paint drums are completely empty before opening the new drum
- Check the paints are approved for use in the designated areas
- After final coating of anti-fouling, minimum drying time to be followed as specified prior flooding the dock
- Remove the grit dust accumulated on the rigged platform prior paint operation to avoid ruining of paint layer

Summary

The quality of painting and cleaning job done on the ship's hull has an enormous impact on the ship's fuel efficiency. As the paint peels off, the surface of the hull significantly deteriorates, resulting in higher drag and increased fuel consumption. The quality of painting carried out in the dry dock depends on a variety of factors, good surface preparation being one of the most important one. Though most of the paint system failures can be traced directly to poor surface preparations, the skill and knowledge of the personnel undertaking the task also plays an important role.

Moreover, measuring hull efficiency is a difficult task which requires assessing a number of factors such as speed, engine efficiency, fuel quality, ship design, propeller condition, environmental factors etc. and the person in-charge of the job should have the necessary knowledge and skills to recognize all these parameters for a successful paint system. As a ship owner, superintendent or seafarer it is therefore imperative that you have a clear picture of what is going on during the painting job in the dry dock.

If you have questions regarding this eBook or any topics mentioned herein, send us a mail at

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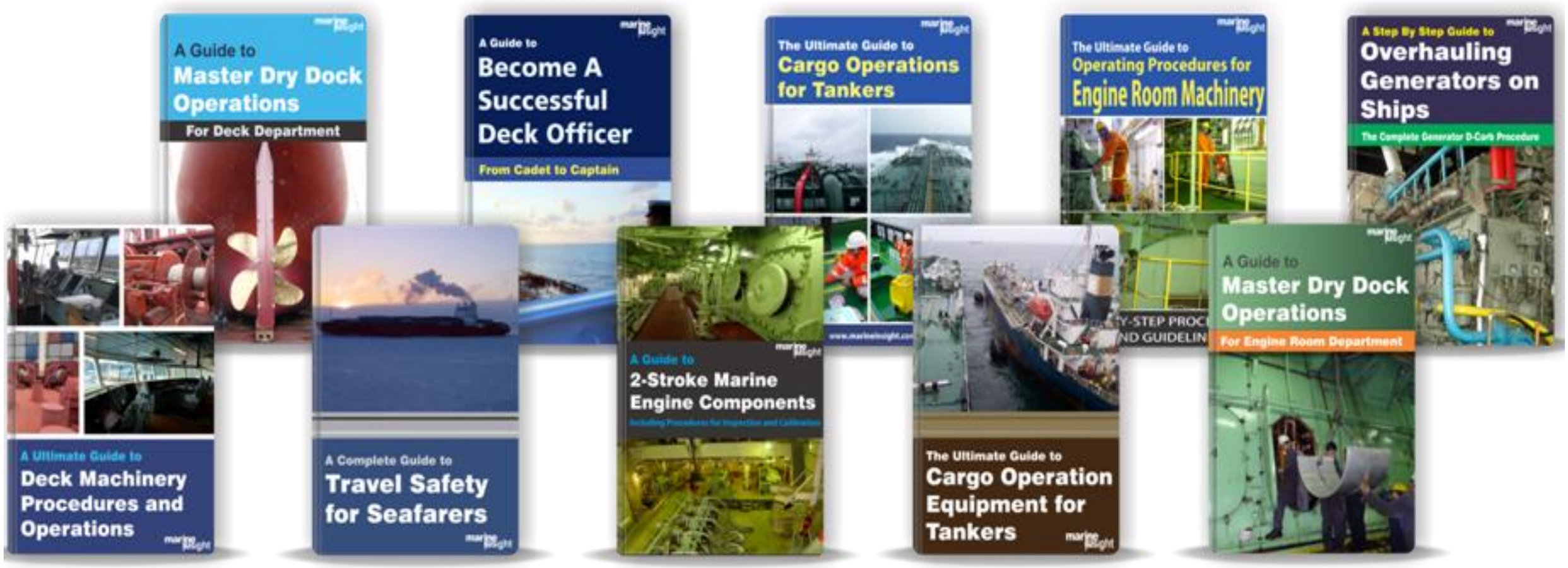

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