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# Analysis Of Paint Material Requirements in the S-80 Tugboat Hull Painting Project

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*Abstract*— **Calculating the paint requirements is a lengthy and meticulous process. Therefore, the company needs to calculate the painting requirements correctly and accurately. The painting process is one of the processes in shipbuilding. The coating process involves painting or layering ship steel plates with special paint to protect the vessel. This research aims to estimate the material and cost requirements for the S-80 tugboat construction project by calculating the needs, coating with 2 different products so that a comparison of materials and costs can be made, namely International and Nippon Paint. The amount of paint needed is determined based on the surface area of the underwater and topside hull of a 26-meter tugboat. This study applies a quantitative method, so resulting in final outcomes presented in numerical form. According the research, he total coating needs for the hull of the ship for the bottom part using the International brand is 111,6 L and for the Top Side is 59,43 L, while for the Nippon Paint brand, the Bottom part is 64,5 L and the Top Side is 57,6 L. For the coating process, the total cost for the bottom and topside areas with the International brand amounts to Rp31.702.000. Meanwhile, for the Nippon Paint brand, the cost for the bottom and topside areas is Rp11.238.000 in total.**

*Keywords*— Tugboat, Ship Hull, Coating.

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## I. INTRODUCTION

Ships an important role in marine transportation for trade and shipping goods between countries. This research about Tugboat that has special specifications. During operation, Tugboat hulls are prone to corrosion due to high speed and sea conditions [1]. To inhibit corrosion, a thorough coating is carried out on the hull [2].

The primary purpose of marine coatings is to provide anti-fouling properties to ships. Almost all types of industrial marine paints possess anti-fouling capabilities due to the inclusion of water-soluble bioactive ingredients and organic compounds [3][4]. These materials function to prevent the attachment of marine organisms such as shellfish, algae, and other fouling species. As the hull is the exterior structure in direct contact with seawater, it is highly susceptible to biofouling. Therefore, the presence of anti-fouling agents can effectively mitigate organism accumulation and reduce the risk of hull damage [5][6].

The coating process commences with a surface area assessment of the tugboat hull section to be treated. Accurate measurement of the wetted surface area is essential for determining material requirements and process planning. Following this assessment, the selection of the coating system—including the specific paint type, formulation, and manufacturer—is conducted based on performance criteria and operational conditions. This selection also forms the basis for the cost estimation framework, ensuring both material efficiency and budget accuracy [7][8].

Several factors must be considered in the painting process to ensure high-quality results that comply with applicable standards.

1. Air Humidity : Painting should be carried out when the ambient humidity is within the range specified by the paint manufacturer to ensure optimal adhesion and curing.
2. Surface Condition : The substrate must be clean, dry, and free from contaminants such as dust, oil, or rust prior to coating application.
3. Application Technique : The painting method—whether brush, roller, or spray—should be selected based on the surface area, geometry, and coating type to achieve uniform coverage and film thickness [9][10].

If the painting process is carried out under conditions that do not comply with applicable standards, coating defects may occur. Such defects must be prevented to maintain coating integrity and ensure optimal performance. Common examples of paint defects include blistering or bubbling, as well as the formation of pinholes, which can compromise the protective function of the coating. [11][30].

Blistering is a common coating defect characterized by the formation of bubbles within the paint film. This defect can result from several factors, including salt contamination embedded in the substrate, high humidity, or elevated ambient temperatures. To prevent blistering, the metal surface must be clean, dry, and completely free from contaminants before the coating application. Another frequent defect is pinhole formation, which

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appears as small holes on the coated surface. This issue is typically caused by air entrapment within the wet paint film, often due to improper spray application techniques or incorrect solvent mixtures [25]. Prevention methods include using correct application techniques, employing properly formulated products with the right solvent ratios, maintaining suitable environmental conditions, and ensuring proper calibration of spray equipment, including the spray gun distance from the surface.

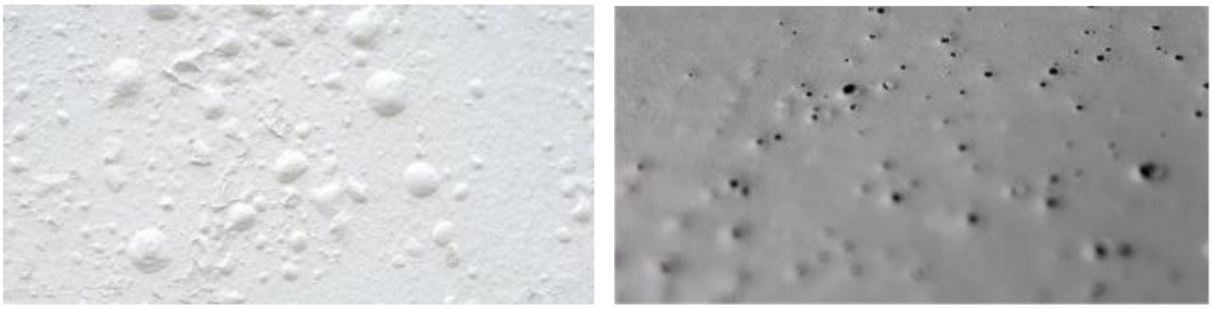

**Figure 1.** Blastering and Pinhole

Paint wastage in hull construction can result from inefficient application techniques, inadequate surface preparation, mixing errors, unfavorable environmental conditions, and the improper selection or use of paint materials [12][13]. Human factors, such as operator error and insufficient supervision, also contribute to material loss. Minimizing wastage requires careful planning, strict quality control, and comprehensive workforce training to ensure that paint application is both efficient and compliant with established standards [14].

This study aims to estimate the coating cost for the construction of a 26-meter tugboat by comparing two paint brands: International and Nippon Paint. The hull coating process comprises three layers—primer, intermediate, and topcoat—applied to both the topside and underwater sections. The analysis was conducted to minimize costs and optimize material efficiency, thereby enhancing the company's operational profitability. The calculation was based on the vessel's principal dimensions to determine the total surface area of the hull requiring coating.

## II. METHOD

### A. Tugboat

Tugboats are high-powered vessels (750-25,000 HP) used to tow or push other vessels, mainly in harbors and on the high seas[1][24]. The hull coating process is undertaken to safeguard the substrate against corrosion and to impart additional functional properties, such as enhanced slip resistance and controlled negative buoyancy. The procedure encompasses several sequential stages: pre-coating inspection, substrate preparation via abrasive blasting, coating material preparation in accordance with manufacturer specifications, and the systematic application of the coating layers, using main equipment such as air compressor and airless spray, as well as auxiliary tools such as blowers and scaffolding [15]. Accurate delineation of the painting zones is critical to achieving optimal protection against marine corrosion[16].

### B. Calculation of Hull Area

In determining material requirements and coating costs, it is necessary to calculate the total hull surface area. For this cargo vessel, the hull comprises side plating and underwater sections. The formula for calculating the area to be coated is presented in [17]. The estimation of the hull surface area to be painted, covering both the bottom and topside sections, is determined using the following equation:

1. Theoritical Spreading Rate

PT Citra Shipyard calculates paint material requirements using internal technical standards with the main parameter Theoretical Spreading Rate (TSR), which is the ability to spread paint per liter on a flat surface [18]. This calculation is based on the paint solid volume value and the desired dry film thickness (DFT)].

$$\frac{vs x 10\%}{desiredDFT(micron)} \qquad (1)$$

Description:

VS: Volume solid

Desired DFT: Paint Thickness

2. Practical Needs

In calculating paint requirements, PT Citra Shipyard considers field conditions such as surface shape, application method, and working environment [18]. To reflect actual consumption, a practical requirement formula is used that incorporates losses, so that the paint estimation is more accurate and in line with real conditions [26][28].

$$Consumption = \frac{\text{Area (m)} x\ of\ need\ factors}{Theorotical\ Spreading\ Rate} \qquad (2)$$

Description:

$$Factor\ of\ consumption = \frac{100}{100-2\%} \qquad (3)$$

$$TSR = \frac{\text{vs x } 10\%}{DFT(micron)} \qquad (4)$$

### C. Calculation of Coating Requirements

To determine coating requirements, PT Citra Shipyard applies the theoretical spreading rate calculation method [19]. TSR or theoretical spreading rate is essential for estimating the total amount of coating material required. It is calculated based on the desired dry film thickness (DFT) of the cured paint layer and can be determined using the following equation [29]:

$$\frac{DFT^0}{TSR^1} = \frac{DFT^1}{TSR^0} \quad (5)$$

Description:
$DFT^0$ = DFT from datasheet (µm)
$DFT^1$ = DFT Plan (µm)
$TSR^0$ = Spread power from datasheet (m²/l)
$TSR^1$ = Planned spread rate (m²/l)

By determining the wetted surface area (WSA) of the ship's hull and the theoretical spread rate of the paint, the coating requirements can be calculated using the following equation:

$$T\ C = \frac{Area}{TSR} \quad (6)$$

$$C\ F = 100\ Lf \quad (7)$$

$$P\ C = \frac{A}{TSR} \text{ x } Cf \quad (8)$$

Description:
T C = Theoretical Coating, the paint required to coating area (liter).
P C = Practical Coating, paint requirement after accounting for the applicable loss factor.
Area = Hull surface area (m²).
TSR = Theoretical Spreading rate, paint spread rate per liter (m²/L) at a specified dry film thickness.
C F = Coating factor, a coefficient applied to determine the required paint quantity, taking into consideration material losses that occur during the application process. The coating factor used is 1,5.
L F = Loss factor.

D. Coating Cost Calculation

To obtain an accurate and efficient estimate of painting costs, PT Citra Shipyard employs a coating cost calculation method adapted to actual operational practices in the field. The calculation incorporates the total hull surface area to be coated, the paint coverage rate per liter, and the unit price based on the product's packaging volume. This formula was developed from internal technical references and has been consistently applied in new shipbuilding projects at the yard, including the S-80 Tugboat. Through this approach, cost estimation can be conducted systematically and aligned with the actual conditions of the project [20][27].

The coating cost calculation formula used is as follows:

$$Coating\ \text{Cost} = \frac{\text{hull surface area} : \text{Area per-liter}}{\text{Liter per pack x Price}} \quad (9)$$

E. Research flow

1. Literature Study

Literature study is carried out to collect data related to and supporting the problems that will be analyzed in this study. The reading sources used can be in the form of e-books, papers, journals, theses and references from the internet.

2. Data Collection

Data collection is done by interviewing workers from the company[21]. Where the data needed are:
- Main size of the ship
- Supporting research images such as photos and data from each paint
- Coating material requirements
- Information from 2 paint products namely International and Nippon Paint

3. Coating on Each Brand (International and Nippon Paint)

At this stage is the calculation stage of coating requirements with International and Nippon Paint brands for painting the hull of a 26 m Tugboat [22][23]. The calculation of the need for each layer of paint can be applied using the following formula 5:

$$\frac{DFT0}{TSR1} = \frac{DFT1}{TSR0}$$

In this research, the formula used to calculate paint requirements incorporates several key parameters derived from the paint data sheet. The first parameter, $DFT^0$, is the Dry Film Thickness (DFT) listed on the paint data sheet in micrometers (µm). The second parameter, $DFT^1$, is the planned DFT thickness, also in micrometers (µm). Furthermore, $TSR^0$ indicates the spreading rate stated in the paint data sheet, expressed in square meter per liter (m²/l), while $TSR^1$ is the planned spreading rate, also in m²/l.

The values of $DFT^0$ and $TSR^0$ can be obtained directly from the paint data sheet used, which provides important information regarding the product's characteristics. When calculating the paint requirements, the figures to be used are those from $TSR^1$, which reflect the planned coverage based on the specific project needs. The results of the paint requirement calculations, including the $TSR^1$ values, are presented in detail in Tables 1 and 2, which provide relevant data for further analysis.

In the table above, the TSR or Theoretical Spreading Rate and paint thickness that has been determined on several coating layers in the topside zone are obtained. For the minimum amount of thickness of the International coating layer is 200 µm DFT, while for the data above it has fulfilled that is 255 µm DFT. As for the minimum amount of thickness of the Nippon Paint coating layer, namely 200 µm DFT, while the data above has met, namely 225 µm DFT.

4. Comparison and Selection of Price and Thickness between International and Nippon Paint

After obtaining data from each product brand, the next step is the comparison and selection of effective paint product brands for the coating process on the S-80 tugboat. This comparison and selection is based on the price and thickness of the paint on the hull.

TABLE 1
TSR COATING FOR INTERNATIONAL BRANDS ON BOTTOM AND TOPSIDE

| | No. | Product | TSR[1] |
|---|---|---|---|
| Bottom | 1 | Intertuf 262 | 5,84 m2/l for 125 µm DFT |
| | 2 | Intergard 263 | 5,7 m2/l for 100 µm DFT |
| | 3 | Intersmooth 365 SPC | 4,06 m2/l for 100 µm DFT |
| Topside | 1 | Interprime 226 White | 4,44 m2/l for 90 µm DFT |
| | 2 | Interprime 226 White | 4,44 m2/l for 90 µm DFT |
| | 3 | Formula 151 Topcoat | 8,27 m2/l for 75 µm DFT |

TABLE 2
TSR COATING FOR NIPPON PAINT BRANDS ON BOTTOM AND TOP SIDE

| | No. | Product | TSR[1] |
|---|---|---|---|
| Bottom | 1 | NOA 10 M | 5,04 m2/l for 125 µm DFT |
| | 2 | Nippon Ceramo T/U M | 9,96 m2/l for 50 µm DFT |
| | 3 | Ecolosilk | 4,8 m2/l for 150 µm DFT |
| Topside | 1 | NOA 10 M | 5,04 m2/l for 125 µm DFT |
| | 2 | Ecoloflex SPC 200 | 6,2 m2/l for 100 µm DFT |

## III. RESULTS AND DISCUSSION

### A. Calculation of Coating Requirements for Each Brand (International and Nippon Paint)

The hull surface area measures 119.46 m² below the waterline and 91.52 m² above the waterline rererespectively. Data required in this study are the results of the calculation TSR[1] obtained previously, which serves as the basis for estimating paint needs and further analysis related to the efficiency of using materials in the painting process. For the arrangement of the bottom and topside paint layers, 3 times the painting process is carried out as follows:

$$PC = \frac{Area}{TSR} \text{ x } 1{,}5$$

This calculation is determined based on formula 8.

Bottom Area

1. International Intertuf 262 (Primer Coat)
   $PC = \frac{119{,}46}{5{,}84} x1{,}5$
   PC = 30,1 liter
   Paint requirement liter/m$^2$ = 30,1 liter/119,46 m$^2$
   = 0,3 liter/m$^2$
   Thinner = 5% x paint requirement
   = 5 % x 0,3 liter /m$^2$
   = 0,015 liter /m$^2$
   = 0,015 x 119,46
   = 1,8 liter
   Intertuf 262 paint and International GTA220 thinner requirements.
   = Paint requirement – thinner
   = 0,30 - 0,015
   = 0,29 x 119,46
   = 34 liter
2. International Intergard 263 (Intermediate)
   $PC = \frac{119{,}46}{5{,}7} x1{,}5$
   PC = 31,4 Liter
   Paint requirement liter/m$^2$ = 31,4 liter/119,46 m$^2$
   = 0,26 liter/m$^2$
   Thinner = 5% x paint requirement
   = 5% x 0,26 liter/m$^2$
   = 0,013 liter/m$^2$
   = 0,013 x 119,46
   = 1,6 liter
   Intergard 262 paint and International GTA220 thinner requirements
   = Paint requirement– thinner
   = 0,26 – 0,013
   = 0,247 x 119,46
   = 29,5 liter = 30 liter
3. International Intersmooth 365 SPC (Finish Coat)
   $PC = \frac{119{,}46}{4{,}06} x\ 1{,}5$
   PC = 44 Liter
   Paint requirement liter/m$^2$ = 44 liter/119,46 m$^2$
   = 0,37 liter/m$^2$
   Thinner = 5% x paint requirement
   = 5% x 0,37 liter/m$^2$
   = 0,0185 liter/m$^2$
   = 0,0185 x 119,46
   = 2,2 liter
   Intersmooth 365 SPC paint and International GTA007 thinner requirements.
   = Paint requirements – thinner
   = 0,37 – 0,0185
   = 0,35 x 119,46
   = 42 liter
4. Nippon Paint NOA 10 M (Primer Coat)
   $PC = \frac{119{,}46}{5{,}04} x\ 1{,}5$
   PC = 35,5 liter
   Paint requirement liter/m$^2$ = 35,5 liter/119,46 m$^2$
   = 0,3 liter/m$^2$
   Thinner = 5% x Paint requirement
   = 5 % x 0,3 liter /m$^2$
   = 0,015 liter /m$^2$
   = 0,015 x 119,46
   = 1,8 liter
   NOA 10 M paint and Nippon Marine Thinner 600 requirements
   = Paint requirements - thinner
   = 0,30 - 0,015
   = 0,29 x 119,46
   = 34 liter
5. Nippon Paint Ceramo T/U M (Intermediate)
   $Pc = \frac{119{,}46}{9{,}96} x1{,}5$
   PC = 18 Liter
   Paint requirement liter/m$^2$ = 18 liter/119,46 m$^2$
   = 0,15 liter/m$^2$

Thinner = 5% x Paint requirement
= 5% x 0,15 liter/m$^2$
= 0,075 liter/m$^2$
= 0,075 x 119,46
= 0,9 liter

Nippon Ceramo T/U M paint and Nippon Marine Thinner 600 requirement
= Paint requirements - thinner
= 0,15 – 0,075
= 0,075 x 119,46
= 9 liter

6. Nippon Paint Ecolosilk (Finish Coat)

$Pc = \frac{119,46}{4,8} x\ 1,5$

PC = 37,3 Liter

Paint requirement liter/m$^2$ = 44 liter/119,46 m$^2$
= 0,31 liter/m$^2$

Thinner = 5% x Paint requirement
= 5% x 0,31 liter/m$^2$
= 0,016 liter/m$^2$
= 0,016 x 119,46
= 1,8 liter

Ecolosilk paint and Nippon Marine Thinner 600 requirement
= Paint requirements – thinner
= 0,31 – 0,016
= 0,15 x 119,46
= 17 liter

TABLE 3
TOTAL PAINT REQUIREMENT OF INTERNATIONAL AND NIPPON PAINT BOTTOM AREA

| No. | Layer | Product | Total | Thinner |
|---|---|---|---|---|
| 1 | Primer | Intertuf 262 | 34 L | 1,8 L |
| 2 | Intermediate | Intergard 263 | 30 L | 1,6 L |
| 3 | Finish Coat | Intersmooth 365 SPC | 42 L | 2,2 L |
| | **Total of International Brands** | | **106 L** | **5,6 L** |
| No. | Layer | Product | Total | Thinner |
| 1 | Primer | NOA 10 M | 34 L | 1,8 L |
| 2 | Intermediate | Nippon Ceramo T/U M | 9 L | 0,9 L |
| 3 | Finish Coat | Ecolosilk | 17 L | 1,9 L |
| | **Total of Nippon Paint Brands** | | **60 L** | **4,6 L** |

Topside Area

1. International Interprime 226 White (Primer Coat and Intermediate)

$Pc = \frac{91,52}{4,44} x1,5$

Pc = 30 liter

Paint requirement liter/m$^2$ = 30 liter / 91,52 m$^2$
= 0,33 liter/m$^2$

Thinner = 5% x Paint requirement
= 5 % x 0,33 liter /m$^2$
= 0,017 liter /m$^2$
= 0,017 x 91,52
= 1,5 liter

Interprime 226 White paint and International GTA004 thinner requirement
= Paint requirements - thinner
= 0,33 - 0,017
= 0,31 x 91,52
= 28,6 liter

2. International Formula 151 Topcoat (Finish Coat)

$Pc = \frac{91,52}{8,27} x1,5$

PC = 16,5 Liter

Paint requirement liter/m$^2$ = 16,5 liter / 91,52 m$^2$
= 0,18 liter/m$^2$

Thinner = 5% x paint requirement
= 5% x 0,18 liter/m$^2$
= 0,009 liter/m$^2$
= 0,009 x 91,52
= 0,83 liter

International Formula 151 Topcoat and International GTA004 thinner requirement
= Paint requirements - thinner
= 0,18 – 0,009
= 0,171 x 91,52
= 15,6 liter

3. Nippon Paint NOA 10 M

$Pc = \frac{91,52}{5,04} x1,5$

Pc = 35,5 liter

Paint requirement liter/m$^2$ = 35,5 liter / 119,46 m$^2$
= 0,3 liter/m$^2$

Thinner = 5% x Paint requirement
= 5 % x 0,3 liter /m$^2$
= 0,015 liter /m$^2$
= 0,015 x 119,46
= 1,8 liter

Nippon Paint NOA 10 M and thinner Nippon Marine Thinner 600 requirement
= Paint requirements – thinner
= 0,30 - 0,015
= 0,29 x 119,46
= 34 liter

4. Nippon Paint Ecoloflex SPC 200

$Pc = \frac{91,52}{6,2} x1,5$

Pc = 22 liter

Paint requirement liter/m$^2$ = 22 liter / 91,52 m$^2$
= 0, 24 liter/m$^2$

Thinner = 5% x Paint requirement
= 5 % x 0,24 liter /m $^2$
= 0,012 liter /m $^2$
= 0,012 x 91,52

= 1,1 liter
Ecoloflex SPC 200 Paint and *thinner* Nippon Marine Thinner 300 requirement
= Paint requirements – thinner
= 0,24 - 0,012
= 0,23 x 91,52
= 20,1 liter

TABLE 4
TOTAL PAINT REQUIREMENT OF INTERNATIONAL AND NIPPON PAINT TOPSIDE AREA

| No. | Layer | Product | Total | Thinner |
|---|---|---|---|---|
| 1 | Primer | Interprime 226 White | 20 L | 1,5 L |
| 2 | Intermediate | Interprime 226 White | 20 L | 1,5 L |
| 3 | Finish Coat | Formula 151 Topcoat | 15,6 L | 0,83 L |
| | **Total of International Brands** | | **55,6 L** | **3,83 L** |
| No. | Layer | Product | Total | Thinner |
| 1 | Primer | NOA 10 M | 34 L | 1,8 L |
| 2 | Finish Coat | Ecoloflex SPC 200 | 20,1 L | 1.8 L |
| | **Total of Nippon Paint Brands** | | **54,1** | **3,6 L** |

A. Calculation of Coating Costs for Each Brand (International and Nippon Paint)

For estimating the coating cost for painting the hull of a 26 m Tugboat using paint with International and Nippon Paint brands is the amount of paint products used to cover the bottom hull with a predetermined thickness per liter. This calculation is determined based on formula 9.

$$\mathit{Coating}\ \text{Cost} = \frac{\text{hull surface area}:\ \text{Area per} - \text{liter}}{\text{Liter per pack x Price}}$$

Bottom

1. International Intertuf 262 (Primer Coat)
   Coating cost = ((119,46 $m^2$ : 5,84 $m^2$) : 20) x Rp 3.500.000
   = 1,02 x Rp 3.500.000
   = Rp 3.570.000,-
2. International Intergard 263
   Coating cost = ((119,46 $m^2$ : 5,7 $m^2$) : 20) x Rp 3.800.000
   = 1,04 x Rp 3.800.000
   = Rp 3.952.000,-
3. International Intersmooth 365 SPC
   Coating cost = ((119,46 m2 : 2,9 m2) : 20) x Rp 7.000.000
   = 2,06 x Rp 7.000.000
   = Rp 14.420.000,-
4. Nippon Paint NOA 10 M
   Coating cost = ((119,46 m2 : 3,6 m2) : 20) x Rp 1.800.000
   = 1,66 x Rp 1.800.000
   = Rp 2.988.000,-
5. Nippon Paint Ceramo T/U M
   Coating cost = ((119,46 $m^2$ : 9,96 $m^2$) : 10) x Rp 1.300.000
   = 1 x Rp 1.300.000
   = Rp 1.300.000,-
6. Nippon Paint Ecolosilk
   Coating cost = ((119,46 $m^2$ : 4,8 $m^2$) : 10) x Rp 800.000
   = 2,4 x Rp 800.000
   = Rp 1.920.000

For estimating the coating cost for painting the hull of a 26 m Tugboat using paint with International and Nippon Paint brands is the amount of paint products used to cover the topside hull with a predetermined thickness per liter. This calculation is determined based on formula 9.

Topside

1. International Interprime 226 White
   Coating cost = ((91,52 m2 : 4,44 m2) : 20) x Rp 3.200.000
   = 1,0 x Rp 3.200.000
   = Rp 3.200.000,-
2. International Formula 151 Topcoat
   Coating cost = ((91,52 m2 : 8,27 m2) : 20) x Rp 4.500.000
   = 0,56 x Rp 4.500.000
   = Rp 2.520.000,-
3. Nippon Paint NOA 10 M
   Coating cost = ((91,52 m2 : 3,6 m2) : 20) x Rp 1.800.000
   = 1,2 x Rp 1.800.000
   = Rp 2.160.000,-
4. Nippon Paint Ecoloflex
   Coating cost = ((91,52 m2 : 6,2 m2) : 5) x Rp 640.000
   = 3 x Rp 640.000
   = Rp 1.920.000,-

For estimating the coating cost for painting the hull of a 26 m Tugboat using Thinner with International and Nippon Paint brands is the amount of paint products used to cover the hull bottom and topside with a predetermined thickness per liter.

Thinner

1. International GTA 250
   Thinner = 5,6 liter + 3,83 liter
   = 9,43 liter
   Price = Rp420.000 per 5 liter
   Cost = 9,43 liter : 5
   = 1,89 = 2 pack
   = 2 x Rp 420.000

= Rp 840.000

2. Nippon Marine Thinner 600
   Thinner = 4,6 liter + 3,6 liter
   = 8,2 liter
   Price = Rp 475.000 per 5 liter
   Cost = 8,2 liter : 5
   = 1,64 = 2 pack
   = 2 x Rp 475.000
   = Rp 950.000

TABLE 5
COST CALCULATION OF INTERNATIONAL COATING AND NIPPON PAINT BOTTOM AREA

| No. | Product | Cost (Rp) |
|---|---|---|
| 1 | Intertuf 262 | Rp 3.570.000 |
| 2 | Intergard 263 | Rp 3.952.000 |
| 3 | Intersmooth 365 SPC | Rp 14.420.000 |
| | **Total Cost of International Brands** | **Rp21.942.000** |
| No. | Product | Cost (Rp) |
| 1 | NOA 10 M | Rp 2.988.000 |
| 2 | Nippon Ceramo T/U M | Rp 1.300.000 |
| 3 | Ecolosilk | Rp 1.920.000 |
| | **Total Cost of Nippont Paint Brands** | **Rp 6.208.000** |

TABLE 6
CALCULATION OF INTERNATIONAL COATING COST AND NIPPON PAINT TOP SIDE PART

| No. | Product | Cost (Rp) |
|---|---|---|
| 1 | Interprime 226 White | Rp 3.200.000 |
| 2 | Interprime 226 White | Rp 3.200.000 |
| 3 | Formula 151 Topcoat | Rp 2.520.000 |
| | **Total Cost of International Brands** | **Rp 8.920.000** |
| No. | Product | Cost (Rp) |
| 1 | NOA 10 M | Rp 2.160.000 |
| 2 | Ecoloflex | Rp 1.920.000 |
| | **Total Cost of Nippont Paint Brands** | **Rp 4.080.000** |

TABLE 7
COST CALCULATION OF INTERNATIONAL THINNER AND NIPPON PAINT

| no. | product | cost (rp) |
|---|---|---|
| 1 | international gta 250 | rp 840.000 |
| | **total cost of international brands** | **rp 840.000** |
| no. | product | cost (rp) |
| 1 | nippon marine thinner 600 | rp 950.000 |
| | **total cost of nippont paint brands** | **rp 950.000** |

## IV. CONCLUSION

Based on the calculations of paint requirements for the S-80 tugboat construction project, a total usage of 111,6 liter of paint and thinner for the Bottom part with the International brand and 59,43 liter for the Top Side has been obtained. Meanwhile, the Nippon Paint brand indicates a lower requirement of 64,5 liter for the Bottom part and 57,6 liter for the Top Side. This shows that Nippon Paint is more efficient in paint usage while still meeting the thickness standards set by PT. Citra Shipyard.

In terms of costs, the total expenditure for International brand paint used on the Bottom and Topside sections reached Rp31.702.000. In comparison, the Nippon Paint brand showed a considerably lower cost, totaling Rp11.238.000 for both sections. Therefore, it can be concluded that Nippon Paint is not only more economical in paint usage but also more cost-effective, making it a preferable choice for coating the ship's hull sections. This study highlights the importance of precise calculations in determining material requirements and costs throughout the ship painting process.

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