Faruk AVCIOĞLU

# APPLICABLE SHIP REPAIR PRACTICE


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EFES MARINE, 2024

# APPLICABLE SHIP REPAIR PRACTICE BY EFES MARINE


**FARUK AVCIOĞLU – 2024**

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**PREFACE**

Hello all!

To be honest, lack of accessible resources and documentation gave me the motivation for this work. In other words, the purpose of creating this book was to enable inspectors, yard engineers and/or ship crews to access information and applicable solutions more easily.

I want you to consider that this book was written by a person who is a non-native English speaker. On the other hand, based on the harmony we achieved with lots of different people in the sector, I believe that you will enjoy it!

In general words, I can say that I tried to offer a study which includes all my experiences and relations I gained up to now during my previous projects. I just wanted to make a resource which can be useful either for beginners or experts in the ship repair industry. I added different links and videos for the ones searching details. I tried to put plenty of visuals for new engineers, officers and mainly marine engineering origin inspectors. I believe that every detail can be helpful for beginners. Besides, I believe that experienced engineers and inspectors can also find different solutions and approaches within this work.

In the book, you will also find information about the products of the companies we represent. Our main purpose here is providing guidance as well as increasing our awareness. Of course, I will not hide this fact from you, but you can be sure about my sensitivity of fairness. I can assure you with peace of mind that my references and partners will approve this without any questions.

The idea came up in 2013, the first words appeared in 2016. Up to now, I always wanted to add more allowed me this much. Recently, I realized that it should come to an end otherwise the content will have a risk of loosing its meaning. And here it is…

I want to thank to Efes Marine Family, my elders and younger colleagues in the industry who always supported me, my worker friends, partner companies who accompanied us with their know-how, vessel teams and superintendents.

Of course, what can I say about my family and friends who brought me to this day; my companion Sinem Eraslan, who stood by me in all my career steps starting from university, helped me to face difficulties in business life, supported me more than I did to start a business and our son ALP, the best gift of the world. Words are not enough, I'm glad to have you…

And finally, in memory of my father Etem AVCIOĞLU (1955 – ∞), who passed away unexpectedly, recently.

**WHO AM I?**

I am Faruk AVCIOĞLU, Naval Architect and Marine Engineer and father of Alp.

I have been involved in marine industry for 20 years, specialized in corrosion and ship repair applications. I founded Efes Marine in 2014. We have been offering sales and technical support services for over 10 years.

My educational and expertise background:

- Naval Architect and Marine Engineering (Yıldız Technical University, 2009)
- Frosio (Level III) – Coating Inspector (2020)
- Gases Free Expert (2020)
- Yacht Coating Inspector (2010)
- Superintendency (DNV GL Training – 2021)
- OPITO – BOSIET & CA – EBS Training (1773 ITU – 2024)

Work Experience:

- Repair Shipyards (Torlak & Gemak Shipyards)
- New building – Design (Selah Shipyard – Tomay Design Office)
- Efes Marine – CEO (2014 – …)

I had a chance to work as a project engineer, estimator, coating inspector, superintendent, and service engineer on over 1000 projects in the industry. Because it is often difficult to remember the name, I am putting a photo of me, to help you recall more easily.

**P.S.** Our book is free to download, can be used only for educational purposes.

Donations to the following organizations are welcomed.

- https://ahbap.org/disasters-turkey - Earthquake victims 2023 – Türkiye
- https://en.losev.org.tr/ - For children with leukemia (Cancer)

# Article I. SAFETY FIRST – SAFETY APPLICATIONS IN YARD AREA

**"SAFETY FIRST" is "SAFETY ALWAYS." ~ Charles M. Hayes**

**SAFETY FIRST** is the motto of all industries all over the world. We are human beings, so we wish to always feel safe during work or in our lives—all parties' efficiency, quality, and performance increase with a secure environment.

Ship repair & new building yards are nearly some of the most challenging working environments in the world. We can meet all kinds of unsafe situations during work. In this environment, we must take all precautions before problems because our risk is **human life!**

Safety is acting firstly on human rights to live. In addition to that, protection also affects companies' prestige. Yards and customer prestige are significant to survive in business life. So, if both parties can manage the safety onboard with good communication, each party can see their future.

Therefore, with this vision, we can explain some of the main safety instructions during the yard period, which must be clearly understood by the vessel crew, yard teams, and third parties.

*Figure 1 - Undocking Operation*

## Section 1.01 Safety Applications in Yard Area

Yards work with international companies, so all parties must understand each other clearly. Therefore, all parties must agree on a communication language (mostly English) to manage the projects in safe conditions. Suppose the communication language needs to be fixed in order. In that case, both parties must put some people as translators for secure communication, but a better way is for ship-owners to select the areas where their team can communicate with the yard teams in good order.

The yard project team and vessel team must carry out initial safety meetings onboard. Before starting any listed works, people must be in the meeting room to follow up on all the details and explain the comments related parties must clarify to the participants. Typically, the safety meeting of the project is carried out by the yard project manager, but the vessel master (and their team), who knows the vessel better than anybody onboard, is also part of that meeting. All parties must explain the details clearly and cooperate 100%.

The attendees can change according to yard or ship-owner company policies. Mainly a list of the meeting room attendees given in the table.

*Table 1 - Safety Meeting Attenders*

| YARD TEAM | VESSEL TEAM |
|---|---|
| **Project Manager** | **Vessel Superintendents** |
| **Project Safety Engineer & Forman** | **Master, Chief Engineer** |
| **Project Planning Engineers from Related Departments** | **Officers – Engineers – Safety Officers** |
| Steel, Pipe Engineer's & Forman's | **Vessel Electrician** |
| Foreign Specialists (Both Team) | **LOTO Engineer** (If company have) |

The attendees can change according to yard or ship-owner company policies. Mainly, a list of the meeting room attendees was given at the table.

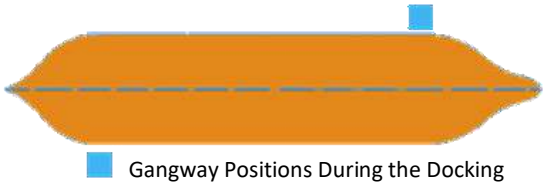
The minimum number of attendees with bold characters must be in the meeting room during the initial safety meeting. Those attendees can manage vessel crews and yard crews during the repair period. Typically, the yards' team is more familiar with repair activities than the vessel crew. However, we must think that most vessels have different systems, tank arrangements, electronic equipment, etc. Both parties are on the same level regarding safety instructions, but all teams must help each other with the safety items.

Usually, most of the safety items are the same for most of the vessel types. Still, sometimes extra precautions must taken because of vessel type, project load (so much steel renewal, etc.), or last cargo

that the vessel carries, etc. According to safety meeting notes, the items listed are the most important that all teams must carry out.

- Vessel tanks and void spaces must be gasses-free, and for tankers before yard entrance, gases-free certificates (cargo tanks) must be checked by an approved third party.
- Both parties must clarify the emergency communication plan (list of people with telephone numbers, local phone onboard, safety gong or button onboard, etc.).
- Vessels' "general arrangement plan - capacity plan" must be declared to the yard team with a highlighted FO, DO, LO, etc. tank arrangements, and all borders of the tanks need to be marked (i.e., with min. 0,5 m extensions) from outside. Names of the tanks must be written in the local language and English.
- Declaration of the last three cargoes that the vessel carries (For tankers etc., MSDS technical information, etc.) must be shared with a yard.
- The yard team must declare "work permit procedures" to all parties. Usually, all hot works must be carried out by yard teams onboard during the yard periods.
- If it's possible, most of the equipment must be pneumatic type for safer work, but If the yard or vessel has no chance to use pneumatic tools (grinders, drilling machine, etc.), electrical equipment can be used onboard with some voltage limits and extra precautions – if necessary.
- The vessel team must use vessel tools, and the yard team must use yard tools.
- Except for accommodation, everybody must wear their own PPE.
- All open areas (manholes, hatch comings, skylights, etc.) must be secured by the yard or vessel team with safety handrails or gratings during the repair period.
- For tank inspections or works, daily or hourly (every 6 – 8 hours) safety inspections must be carried out by yard teams according to the work scope. The yard team must prepare "tank entrance permission" for safe entrance (Green Label – Safe Entrance, Red Label – No Entrance, etc.).
- For working in high areas (more than men's height – staging, cherry picker, cranes, etc.), each person must wear a safety harness, and during the working, it must connect to safety points or wires.
- For vessel crane usage, all crane certificates must be checked by the yard team and must be valid, but for safety, yard teams must test them because of longer operation periods during the yard repairs.
- Operating of any equipment for testing (propeller, rudder, main engine, boilers, etc.) must confirmed by all parties with a witness of watchman's, and all areas must be free from people for safe operations.
- The vessel team must lock vessel CO2 rooms or dangerous areas.
- Fireline connections from shore must be pressurized (~6 bars), and fire watchmen must be on duty 7/24.
- Vessel alarm monitoring systems (fire alarms, smoke alarms, etc.) must be fully in working condition 7/24. If any repair is needed (which can activate the system to alarm position) within a limited time, the system can wait on standby position with extra precautions.
- Daily safety meetings with the yard and vessel team must be carried out onboard.

- The yard and vessel team safety drills can be managed onboard to check the quality of the precautions. In addition, a safety toolbox can be carried out in the working area with workers. However, each party should be careful about how sometimes drills can reduce the reflex action of workers during actual incidents if they happen so much.
- All people have a right to stop any job if they think it is unsafe, and all people have a right not to do any job if they feel unsafe.
- At least two gangways need to be arranged for vessel entrance. Gangways can be placed on one side forward and the aft location on the same side; diagonal gangways can be set during the berthing condition.



Gangway Positions During the Docking

Gangway Positions During the Berthing

*Figure 2 - Gangway Positions During the Shipyard Period*

- Rudder and propeller operations can be managed with a witness of a minimum of 2 crew (one outside, dock – one inside, engine room) with an agreed standard communication system.

*Figure 3 - Gangway (Passageway) Examples in Shipyard*

- Boiler tests must be carried out in a crew-free environment in the way of the funnel location.
- All pressure tests must be carried out within safe distance limits to the locations.


*Figure 4 - Safety Precautions in Shipyard*

*Figure 6 – Typical Shipyard Worker*


*Figure 5 - Shipyard Safety Training Center (Desan Shipyard)*

### (a) Lock Out – Tag Out (LOTO) Systems

LOTO is a safety procedure used in industry and research settings to ensure that dangerous machines are properly shut off and cannot start up again before maintenance or servicing work is completed. The main philosophy of the system is to show all workers that "We are working in that system or machine, so be careful that you don't operate the system. Also, I don't trust you about that order, so for this reason, all keys that can open or operate those systems are together with me without any spare or copy."

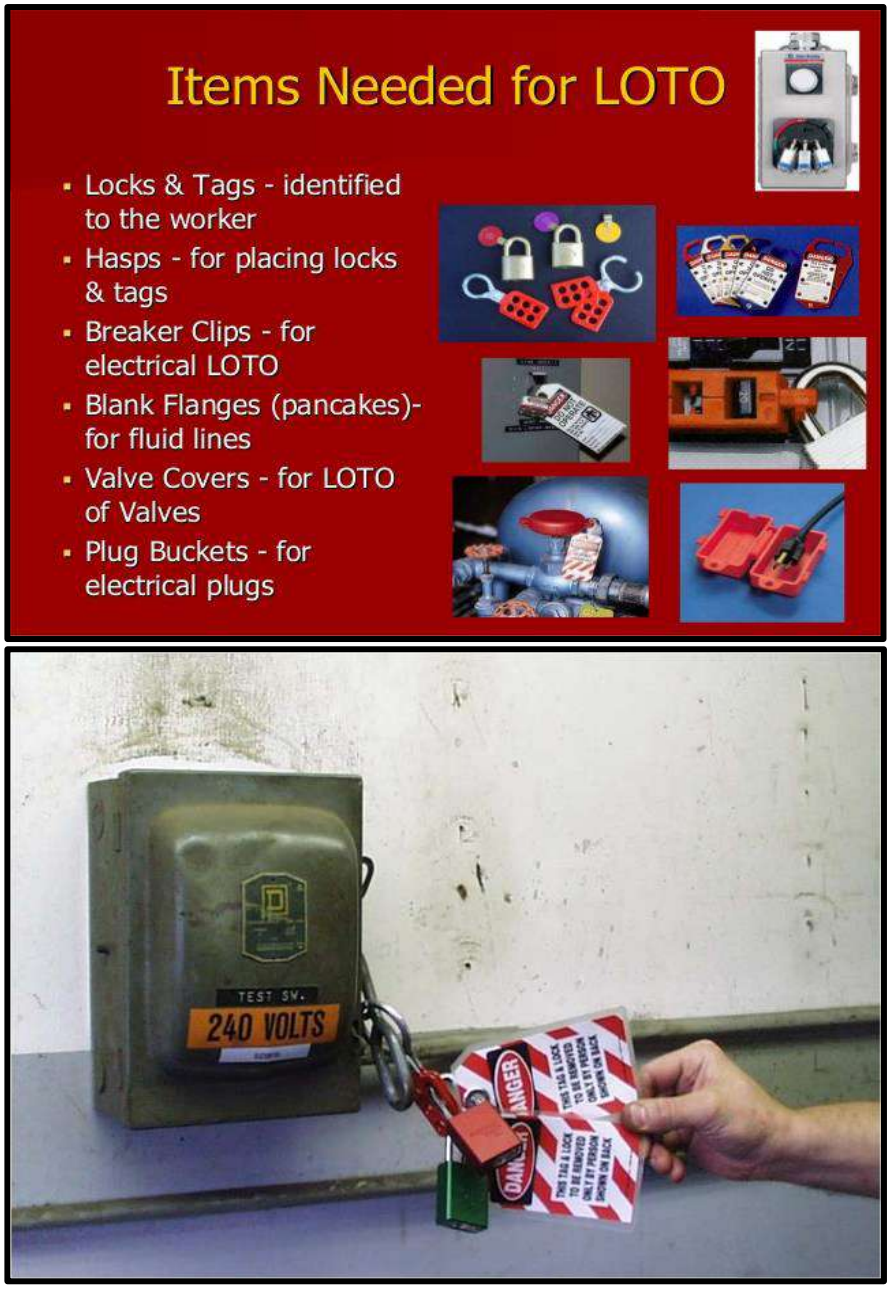



*Figure 7 - Multiple Team Working (LOTO)*

When two or more workers work on different parts of a more extensive overall system, the locked-out device is first secured with a folding scissors clamp with many padlock holes capable of keeping it closed. Each worker knocked their own padlock to the clamp. The locked-out device can only be activated once all workers have signed off on their portion of the project and removed their padlock from the clamp.

OSHA is one of the most known authorities on safety for industrial applications. The following information is standard for both shipbuilding and ship repair activities:

- Access and Guarding of Work Surfaces [29 CFR 1915 Subpart E]
- Cleaning and Other Cold Work [29 CFR 1915 Subpart C]
- Confined or Enclosed Spaces and Other Dangerous Atmospheres [29 CFR 1915 Subpart B]
- Electrical Circuits and Distribution Boards [29 CFR 1915 Subpart L]
- Fire Protection [29 CFR 1915 Subpart P]
- General Working Conditions [29 CFR 1915 Subpart F]
- Hot Work (including Welding, Cutting and Heating) [29 CFR 1915 Subpart D]
- Ladders [29 CFR 1915 Subpart E]
- Machinery and Piping Systems [29 CFR 1915 Subpart J]
- Materials Handling (including Gear and Equipment for Rigging) [29 CFR 1915 Subpart G]
- Pressure Vessels, Drums and Containers [29 CFR 1915 Subpart K]
- Painting and Other Coatings [29 CFR 1915 Subpart C]
- Personal Protective Equipment (PPE) [29 CFR 1915 Subpart I]
- Scaffolds (Staging) [29 CFR 1915 Subpart E]
- Surface Preparation [29 CFR 1915 Subpart C]
- Tools and Related Equipment [29 CFR 1915 Subpart H]
- Typical Health Hazards [29 CFR 1915 Subpart Z]



*Figure 8 - Safety Rules for Shipping Industry*

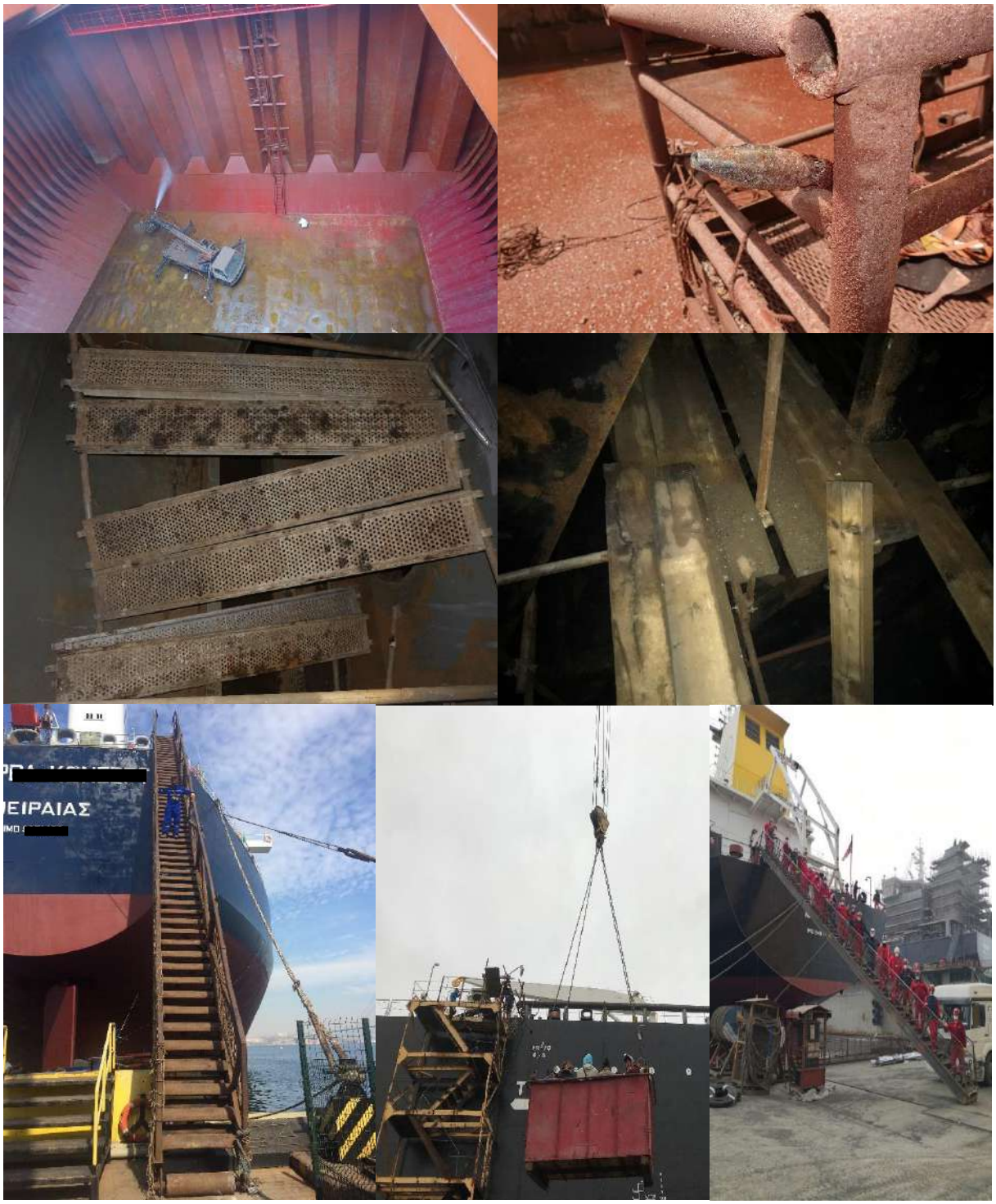



*Figure 9 - Unsafe Shipyard Applications*


*Figure 10 - Safety Applications at Yard*

## Section 1.02 Application of Safety Precautions During the Tank Entrance, Cleanings

All locations used for storage, cargo, or voids are known as tanks onboard. Therefore, these areas are closed spaces where we cannot control 100% of their condition, ventilations, gas levels, etc. For that reason, during yard or crew work, safety officers or workers need to check the gas levels of the tank (including ballast tanks) before entering any tank.

**PERMIT TO WORK FOR ENTRY**

**INTO ENCLOSED/CONFINED SPACE**

| | | | |
|---|---|---|---|
| VESSEL NAME | | DATE/HOURS | |
| IMO NUMBER | | LOCATION | |
| VESSEL MASTER | | PROJECT MANAGER / PROJECT ENGINEER | |
| CO / CE | | WORK DEFINITION | |

| | Checklist Items: | Confirm | Comment |
|---|---|---|---|
| 1 | Space thoroughly ventilated | | |
| 2 | Atmosphere tested and found safe<br>Oxygen % vol. (21%)<br>Hydrocarbon % LFL (less than 1%)<br>Toxic gases ppm (less than 50% OEL of the specific gas) | | |
| 3 | Space secured for entry | | |
| 4 | Rescue and resuscitation entrance | | |
| 5 | Testing equipment available for regular checks (Gases Detectors etc.) | | |
| 6 | Responsible person in attendance at entrance | | |
| 7 | Communication arrangements made between person at entrance and those entering | | |
| 8 | Access and illumination adequate | | |
| 9 | All equipment to be used is of appropriate type (Ex-proof etc.) | | |
| 10 | Personal protective equipment to be used (Boiler Suits, Helmet etc.) | | |
| 11 | Hard hat, safety harness as necessary | | |
| 12 | When breathing apparatus is being used | | |
| | (i) Familiarity of user with apparatus is confirmed | | |
| | (ii) Apparatus has been tested and found to be satisfactory | | |

**NOTES / COMMENTS:**

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VESSEL SIGNATURE

CLEANING TEAM SIGNATURE

www.efesmarine.com.tr

Form: CL/01/001-Rev.00

*Figure 11 - Sample Form for Tank Entrance*

The above form is a sample for tanker cargo tank cleaning works (It can be used for fuel, sewage, oil tanks, etc.). There is a minimal possibility for ballast tanks or void spaces to produce extra gases during the works. So, initial entrances and entrances after breaks are important for inspections.

Especially for tankers, cargo cleanings, and all kinds of vessels, fuel tank cleanings are the risky cases of cleaning applications onboard. All crew members need to be careful about that kind of cleaning work.

The items listed are the primary tools and equipment for cleaning works.

- Workers must wear their PPE.
- Labels must be in all crew language.
- Ex-proof ventilation must be used.
- Ex-proof lighting has to be used (Pneumatic projectors, etc.).
- Zone 0 – 1 headlamps can be used during the cleaning work.
- A waste management plan must be prepared.


*Figure 12 - Safety Warning Signs*

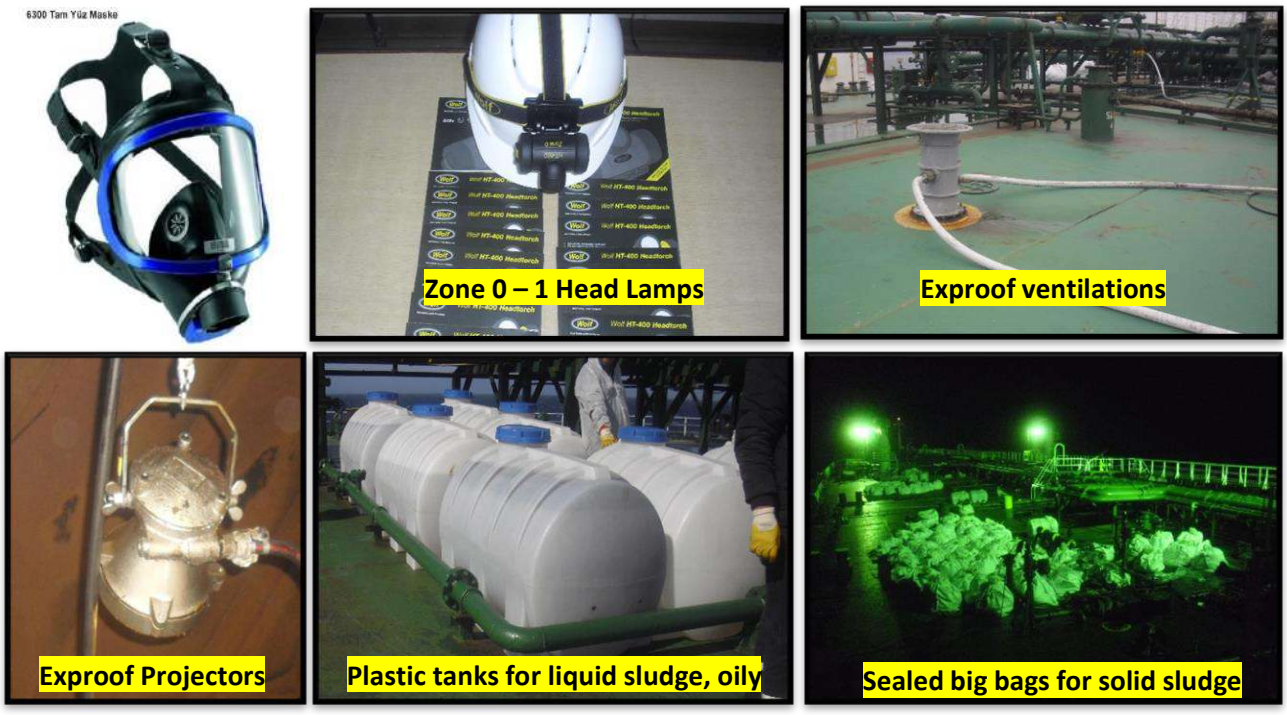



*Figure 13 - Safety at Tank Cleaning Works*

## Section 1.03 Tank Cleaning for Docking and for Turkish Shipyards

Cargo tank cleanings are mandatory for tanker vessels before docking operations or onboard hot work permissions. The vessel must be in “Gases - Free” condition.

- Tanks must be free from slop, sludge, or other cargo residues, and all those residues must be collected and transferred to disposal facilities via an agent yard (depending on country regulations).
- Main cargo lines, cargo pumps, cargo tanks, and slop tanks must be in “Gases-Free” condition, and all measurements must be done by an independent “Gases-Free Expert”.

Tank cleaning works can be managed by ship crew or contractors around the shipyards or anchorage areas. For tanker vessels, if the estimated sludge is above ~10 $m^3$ (total), contractor usage will be helpful for that kind of project.

For Turkish Shipyards, there are two major cleaning locations for vessels. Tuzla anchorage area (1) and Çanakkale (Dardanelles) anchorage areas (2) are the locations for vessels. Location selection is one of the critical for the docking period. If tank cleaning is planned for Dardanelles anchorage, the vessel docking period can be delayed by 2 – 5 days due to wind statistics, waiting for Dardanelles transits, foggy days, etc. In Dardanelles, a limited team arrangement can also delay the scopes. Boat transfers are 3 – 4 times more expensive than Istanbul – Tuzla anchorage costs.

*Table 2 - Cargo Tank Cleaning Comparison for Turkey*

| **Items** | **İstanbul – Tuzla Yalova Anchorage (1)** | **Çanakkale Dardanelles Anchorage (2)** |
|---|---|---|
| Distance to shipyards | 3 – 10 km | ~ 320 km |
| Starting of works after vessel arrival | 2 hours | 8 – 24 hours |
| Yard entrance after cleaning works | 1 – 3 hours | 24 – 72 hours depends on Dardanelle's transit |
| Gases Free Inspections | ~2 hours | 6 – 8 hours in Dardanelles + ~2 hours at Tuzla&Yalova Anchorage |
| Boat Transfer Costs | 1X | 3X – 4X |
| Risks for weather | NA – Near to shipyards | Wind, fog, Queue for passage |
| Ambulance or Urgent Case Reachable | ~15 – 30 minutes | 3 – 4 hours |
| Additional team arrangements for additional work scopes | Around 4 hours | Around 24 hours |
| Gases Free Costs | 1X | 3X |
| Inspection possibility during the cleaning works | Possible by yard and superintendent | Nearly impossible |
| Crew accommodation | Can stay onboard or possible to change | Must stay onboard |
| Equipment & Meal arrangements | Daily boat transfers are possible with low fee | Daily transfers are costly and, in some days, impossible. |
| Costs for cleaning (Just $m^3$ prices) | 1X | 1X |
| **TOTAL CLEANING COSTS** | 1X | 1,4X – 3X |


*Figure 14 - Tank Cleaning Location Map for Turkish Shipyards*

As a strategic location selection, additional costs for Dardanelles are more costly than the Istanbul – Tuzla anchorage areas. If you need any help, please don't hesitate to contact us for technical advice and a quotation.


*Figure 15 – Cargo Tank Cleaning Locations in Turkey*

## Section 1.04 Paint Application in Confined Spaces

Tank coating applications are the strict applications for workers and safety departments of the yards. Most of the coating products contains solvents so during the application, especially for spraying, that solvent accumulate bottom sides of the tanks. That accumulation can create explosions or gas poisonings. The major precautions for tank coating applications are listed bellows.

- Ex-proof lightening must be arranged by team.
- Ventilation system of the tank start from bottom to top.
- If it is possible, some access plates need to be open on the bottom of the location.
- All hot works must stop adjacent tanks.

**OR**

- Solvent-free, class-approved Chemcoint Tank Coating Systems (RS 500P + RA 500M) can be used for tank application. That application can reduce application time or above risks due to solvent-free structure.
- Low VOC levels,
- Rust and wet tolerant epoxy systems…

*Table 3 - Standard Epoxies Tank Coating Application Plan – Nearby Location Working*

| | | |
|---|---|---|
| No:1 PS WBT<br>No coating work can be permitted. | No:1 Cargo Tank<br>Coating work can be permitted. | No:1 STBD WBT<br>No coating work can be permitted. |
| No:2 PS WBT<br>**Steel works** | No:2 Cargo Tank<br>No coating work can be permitted. | No:2 STBD WBT<br>**Steelworks** |
| No:3 PS WBT<br>No coating work can be permitted. | No:3 Cargo Tank<br>Coating work can be permitted. | No:3 STBD WBT<br>No coating work can be permitted. |
| No:4 PS WBT<br>Coating work can be permitted. | No:4 Cargo Tank<br>Coating work can be permitted. | No:4 STBD WBT<br>Coating work can be permitted. |
| No:5 PS WBT<br>Coating work can be permitted. | No:5 Cargo Tank<br>Coating work can be permitted. | No:5 STBD WBT<br>Coating work can be permitted. |
| **CHEMCO SYSTEM TANK COATING APPLICATION PLAN – NEARBY LOCATION WORKING (SOLVENT FREE)** | | |
| No:1 PS WBT<br>Coating work can be permitted. | No:1 Cargo Tank<br>Coating work can be permitted. | No:1 STBD WBT<br>Coating work can be permitted. |
| No:2 PS WBT<br>**Steel works** | No:2 Cargo Tank<br>Coating work can be permitted. | No:2 STBD WBT<br>**Steel works** |
| No:3 PS WBT<br>Coating work can be permitted. | No:3 Cargo Tank<br>Coating work can be permitted. | No:3 STBD WBT<br>Coating work can be permitted. |
| No:4 PS WBT<br>Coating work can be permitted. | No:4 Cargo Tank<br>Coating work can be permitted. | No:4 STBD WBT<br>Coating work can be permitted. |
| No:5 PS WBT<br>Coating work can be permitted. | No:5 Cargo Tank<br>Coating work can be permitted. | No:5 STBD WBT<br>Coating work can be permitted. |

# Article II. SHIP REPAIR PROFICIENCY

## Section 2.01 Preparation of Ship Repair Specification

Ship repair activities are complex project management systems that must be carried out within a limited time. For normal repair activities, project management systems teach us that initial inspections must manage before plenty of time. For the shipping industry, inspections can start 6 – 9 months before and be completed around 3 – 4 months before docking time for standard docking works. With this data and vessel reports, the "Ship Repair Specification" can be ready for the yard period.

The yard and ship owner relationship is like "Doctor–Patient." According to Ship Repair Specifications, yards are preparing their quotation with some repair methods as per standards (IACS, manufacturers, etc.). General maintenance items (steel renewal, pipe renewals, valve overhauls, hull coating works, etc.) are carried out in the yard area as standard work. Still, in some cases, yards must show approved or engineering repair methods to the ship-owner company. Details of the quotation show us the yard's initial quality and proficiency.

Of course, some repairs cannot be suggested to the owner before onboard inspections or after the removal of related items. In those situations, yards can give general repair solutions with estimated costs. These system owners feel safe about their budget and can arrange additional budgets for some other works. Detail specification is very valuable for shipyard and ship-owner for repair budget, time, and quality.

In addition, vessels are living platforms, so during chartering or loading, additional problems or maintenance requirements can occur before docking time. These problems must be recorded and reported to the office to manage repair activity, budget, and spare arrangements during the technological era. These kinds of issues can be seen with photos or videos for better explanations to all parties.

Owner teams must manage scheduled maintenance programs and supply of spares for the vessels. Mostly, these supplies need international transportation and require some fabrication and transportation times (Engine - Propulsion Systems 2 - 6 Months, Cruise Vessels ~Up to 2 years fabrication time). Some parts can be fabricated in a day, but some can take a couple of months or years; for this reason, supply chain management must planned by the owner, yard, or other parties very carefully.

The owner needs some strong and reliable partners for supplies in the yard area. These companies can solve so many problems with a quick response and with their local knowledge.

For this reason, agency and ship supplier (Chandler) selection is also very critical for the ship-owner side. Sometimes, reliable partners can be supported even if their prices are higher than (In fairness, like levels 3 - 10%) their competitors.

Another problem is the management of the manufacturer specialists for the repair periods. The owner team can arrange approved company specialists from the manufacturer or agree with a yard for local specialists, etc. Arrangements of the hotels, transportation – flight management, and daily working plans during repair periods must be organized clearly. Delays can cause vessel schedule changes; loss of money or early invites can cause it again. Service suppliers also have their workload and limited human & resources, so critical items must be calculated carefully.

## Section 2.02 Yard Selection Criteria

Yard selection for the repair activities is another complex system for the ship owners. So many items affect the owner's decisions; listed items are the main items, which can increase according to company policies or experiences.

1. **Vessel location:** Nearby shipyards are important for selection criteria. Fuel prices, supply chain, and chartering market conditions are changing the location range. If the vessel has standard docking items, it can manage them in the nearby shipyard to save time.

2. **Yard capacity:** Vessel dimensions, flag, approval of the yard from societies, crane capacities, berthing capacities (extra shifting, double berth, etc.), docking capacities (for unexpected works), engineering (enough project manager, engineers, experienced supervisor, etc.) worker capacity and can work 7/24 for urgent situations. Engineering skills of the yard can reduce the docking period of the vessel and reduce the budget for all parties.

Especially if the vessel has a hatch cover repair, suitable crane capacity, barge capacity, and yard area are needed for proper repairs. Also, Roro vessel repairs needed some berth or dock arrangement to support aft – forward or side ramp repairs or length of Framo Cargo – ballast pipe height is critical for lifting height of yard cranes together with vessel draft.

3. **Safety on yard:** That part is directly related to human rights and experience of the yard; safety records and statistics can be vital for the owner. If any safety failure happens during the repair period, the owner and yard can lose their people (cannot be compensated), prestige, and money. Vessels can be delayed because of those items irremediably. Labor rights can also be one of the critical items for all parties.

*Figure 16 - Failing of Dock Gate*

4. **Facility condition and management:** Maintenance of the facility is so important for massive operations. During the docking operations, yards manage thousands of tons of ship loading operations, and with their graving or floating dock, they are managing again thousands of tons of seawater transportation. It is essential that ISO – OHSAS regulation of the yard is necessary. Also, an authorized company is essential for certificate control, and mainly, IACS members are good for our industry. Also, the ship-owner can send their team for an initial inspection for audit. Local representative companies can also share their updated knowledge.

5. **Types of repair work:** Some shipyards or shipyards areas have specialized vessel repair systems. Suppose there are giant steelworks (or stainless-steel works). In that case, yard experience must be checked for those workloads. Experience in chemical cargo tank coating works (yards machine park and applicator quality), mechanical works (dredgers repairs, special pump repairs), engineering capacity (quality of design department, operation department), or workshop quality can be helpful for related works. The budget of the project can affect the range of vessel locations. That item must also include yard approvals for special works. Stainless steel or duplex steel approvals, boiler pipe approvals, or workshop approvals must be checked in advance if the vessel has special works.

6. **Logistics (transportation – airport deliveries – nearby workshop availabilities):** Easy crew transportation, repair specialists, vessel spares, ship supply availability, flight availabilities, etc. of the yards are very important. The hinterland of the yards must be very good for local markets and companies. In the Istanbul & Yalova area, all team and equipment–spare deliveries can be managed in 24 hours with direct flights.

Also, nearby workshops are essential for quick and approved solutions for non-standard or mechanical repairs. I.e. In the Istanbul area, most maker workshops (service stations) are in the 15 km range for repairs and inspections. That is also one of the benefits and cost-effective solutions for ship-owners.


*Figure 17 - Direct Flights from Istanbul to Other Countries (Daily Flights) – Just Turkish Airlines*

7. **Pricing of the yard:** Many people think it is the most critical point of yard selection. Yes, it is true, and no, it is not true! Important and critical points show themselves in the details. Quotation quality means details of the prices, easy-to-understand offer details, unit prices, and correct quantities, which are very important. When the quotation is received, both parties must understand the same thing about related items. The total budget of offers needs to show accurate figures on initial proposals. For that reason, the yard marketing team must share the general service prices and estimated quantities in the initial quotation, and the owner team must check the prices and compare them with the other offers with the same range. The quality of the Ship Repair Specification can directly affect the quality of the Yard Quotation.

8. **Payment terms – cash flow of the yard:** This item is related to the yard's economic potential, owner reliability, project budget, etc. Some yards can complete the payment before vessel departure, but some can add payment terms (50% before departure (Long-term projects may also need interim payment), 25% 30 days, 25% 60 days, i.e.). In any case, the payment terms act as discounts and prices directly.

Before booking, the yard may have asked for 10 – 15 % of the initial payment to make the docking slot free for the owner, but this way is very rare, or maybe the owner has a bad reputation in the field. On the other hand, for long-term projects or conversions (If some initial supplies are needed), the yard

has a right to request some initial payment in advance for supplies and the start of prefabrication. The right way is to check the project and agree with the yard, which is feasible and fair.

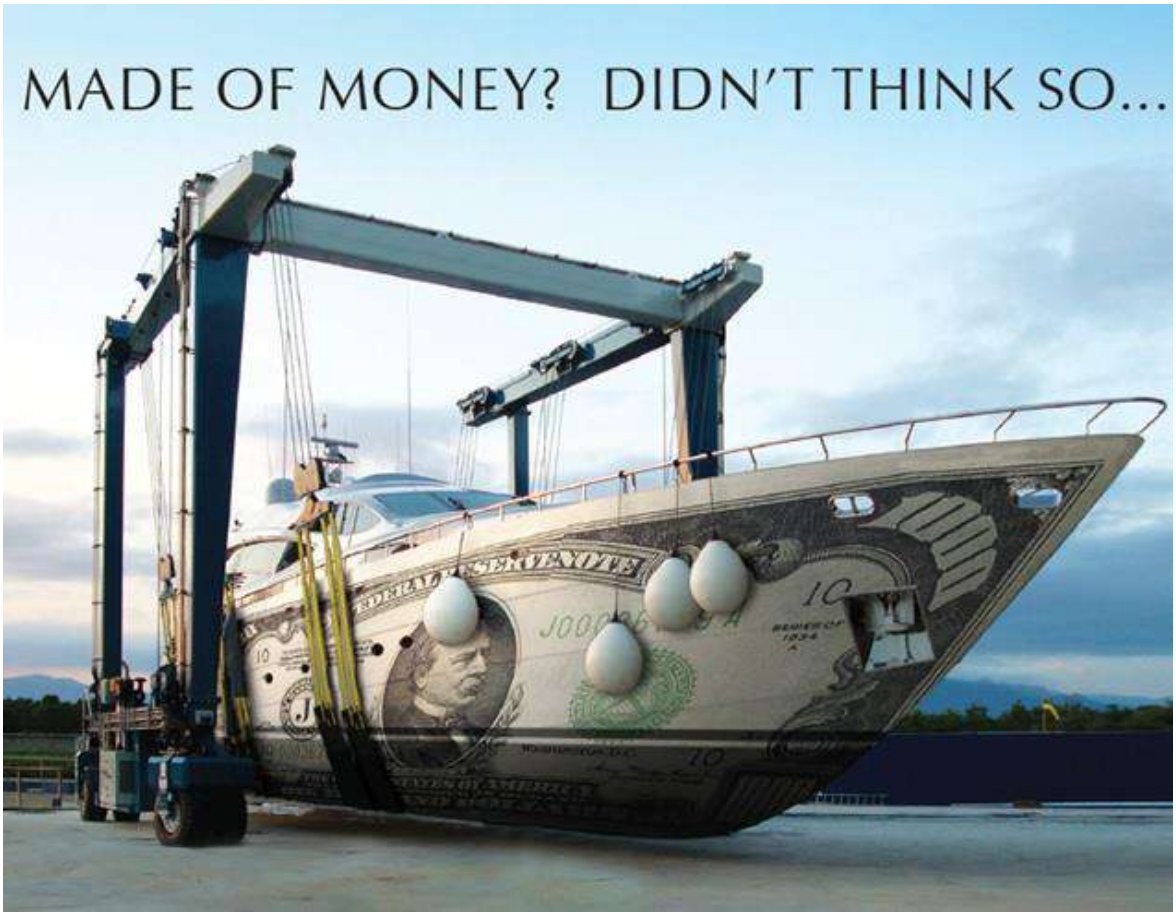



*Figure 18 - Pricing of Yards (Boero Yacht Coating Advertisements from 2000's)*

9. **References of the yards:** Yard references are important for new customers. According to relations, owners can quickly check the reliability of the yards with reference companies and superintendents. We live in a global village, so it is easy to check the reliability of companies with Google or some calls.

10. **Project period:** According to market and yard capacities, during the quotation periods, yards also offer the project completion within a time frame. Delays in the project can cause loss of jobs on the market; owners are very strict about that item. The owner can put some limited penalty items for delays, but vice versa. Yards can also suggest some bonus items for early completion.

11. **Local holidays, public days, etc.:** Related to the project period, ship owners need to also check the public or local holidays during the project periods in advance. Unwanted surprises (the reality of the country or location) can delay the vessel without any chance to cover. The above item is not just for the shipyard; also, the ship-owner needs to check other party's special days. Generally, Chinese New Year (~23 days), Christmas to New Year (~9 days), or Ramadan and Sacrifice Bairam (~4 days + 5 days) need to be checked in their scope. During those public holidays, for Turkey, the best way is to be in the dock because even on the first days, hull coating works are not stopping, and foreign services (Bonding, etc.) can work very well during that period.

12. **Fairness of the yard:** During the project or quotation period, some additional items and works can be onboard. In this situation, owners are looking for yards' additional offers quality. The existing vessel offers for the same companies or standard market prices are acceptable for both parties. Again, maybe some particular works yard is paying more than usual so the cost can be higher. There is a thin line between cheating and fairness. If the owner feels "cheating" about the last-minute work, the yard can earn hundreds or thousands of dollars in a day. Still, it can lose millions of dollars shortly from the same company and un-satisfied advertisement of that company.

13. **The climate of the yard region:** Depending on the repair type, the environment of the yard location is one of the critical items. For example, if the ship-owner decides to apply silicon-type antifouling on its vessel, Istanbul is one of the best options because of humidity and temperature. Even in winter conditions, the temperature is 70 – 75% of the time above 10 °C. For hull coating applications, more than 340 days of the year are without rain and between 10 °C and 35 °C. Even on rainy days, there may be a couple of hours free from rain and humidity so that application can be carried out on time.

Managing coating works or steelworks inside the tanks is challenging during monsoon rains or hot equatorial climate regions. The tank's temperature can be 15 – 20 Celsius, more than the air temperature. So 24-hour workable locations are better for repairs.
**Istanbul has the best climate conditions for 24/365 ship repair practice.**

*Figure 19 - Climate of Shipyards (Worldwide)*

## ISTANBUL WEATHER BY MONTH // WEATHER AVERAGES

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | 5.7 | 5.8 | 7.3 | 11.7 | 16.1 | 20.6 | 23.1 | 23.2 | 19.8 | 15.7 | 11.6 | 8.2 |
| Min. Temperature (°C) | 3 | 3 | 3.9 | 7.5 | 11.7 | 15.9 | 18.6 | 18.9 | 15.6 | 12.1 | 8.4 | 5.4 |
| Max. Temperature (°C) | 8.5 | 8.7 | 10.7 | 15.9 | 20.6 | 25.3 | 27.6 | 27.5 | 24.1 | 19.4 | 14.9 | 11 |
| Avg. Temperature (°F) | 42.3 | 42.4 | 45.1 | 53.1 | 61.0 | 69.1 | 73.6 | 73.8 | 67.6 | 60.3 | 52.9 | 46.8 |
| Min. Temperature (°F) | 37.4 | 37.4 | 39.0 | 45.5 | 53.1 | 60.6 | 65.5 | 66.0 | 60.1 | 53.8 | 47.1 | 41.7 |
| Max. Temperature (°F) | 47.3 | 47.7 | 51.3 | 60.6 | 69.1 | 77.5 | 81.7 | 81.5 | 75.4 | 66.9 | 58.8 | 51.8 |
| Precipitation / Rainfall (mm) | 102 | 71 | 70 | 51 | 33 | 30 | 24 | 32 | 46 | 73 | 91 | 124 |

## BREST WEATHER BY MONTH // WEATHER AVERAGES

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | 6.4 | 6.5 | 8.5 | 9.7 | 11.9 | 14.6 | 15.9 | 16.3 | 15.1 | 12.2 | 9.2 | 7.1 |
| Min. Temperature (°C) | 4 | 3.8 | 5.1 | 6.2 | 8.4 | 11 | 12.4 | 12.8 | 11.9 | 9.1 | 6.6 | 4.6 |
| Max. Temperature (°C) | 8.9 | 9.2 | 11.9 | 13.3 | 15.5 | 18.3 | 19.5 | 19.9 | 18.4 | 15.4 | 11.8 | 9.7 |
| Avg. Temperature (°F) | 43.5 | 43.7 | 47.3 | 49.5 | 53.4 | 58.3 | 60.6 | 61.3 | 59.2 | 54.0 | 48.6 | 44.8 |
| Min. Temperature (°F) | 39.2 | 38.8 | 41.2 | 43.2 | 47.1 | 51.8 | 54.3 | 55.0 | 53.4 | 48.4 | 43.9 | 40.3 |
| Max. Temperature (°F) | 48.0 | 48.6 | 53.4 | 55.9 | 59.9 | 64.9 | 67.1 | 67.8 | 65.1 | 59.7 | 53.2 | 49.5 |
| Precipitation / Rainfall (mm) | 133 | 106 | 96 | 72 | 71 | 55 | 47 | 64 | 85 | 106 | 125 | 140 |

## LISBON WEATHER BY MONTH // WEATHER AVERAGES

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | 11.7 | 12.4 | 13.8 | 15.4 | 17.5 | 20.1 | 22.4 | 22.7 | 21.6 | 18.7 | 14.6 | 12.1 |
| Min. Temperature (°C) | 8.6 | 9.2 | 10.1 | 11.5 | 13.2 | 15.6 | 17.4 | 17.6 | 16.9 | 14.8 | 11.4 | 9.3 |
| Max. Temperature (°C) | 14.8 | 15.7 | 17.5 | 19.4 | 21.9 | 24.7 | 27.4 | 27.8 | 26.3 | 22.6 | 17.9 | 15 |
| Avg. Temperature (°F) | 53.1 | 54.3 | 56.8 | 59.7 | 63.5 | 68.2 | 72.3 | 72.9 | 70.9 | 65.7 | 58.3 | 53.8 |
| Min. Temperature (°F) | 47.5 | 48.6 | 50.2 | 52.7 | 55.8 | 60.1 | 63.3 | 63.7 | 62.4 | 58.6 | 52.5 | 48.7 |
| Max. Temperature (°F) | 58.6 | 60.3 | 63.5 | 66.9 | 71.4 | 76.5 | 81.3 | 82.0 | 79.3 | 72.7 | 64.2 | 59.0 |
| Precipitation / Rainfall (mm) | 101 | 92 | 72 | 53 | 41 | 20 | 3 | 5 | 23 | 71 | 106 | 104 |

# VARNA WEATHER BY MONTH // WEATHER AVERAGES

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | 2 | 3 | 5.7 | 10.8 | 15.6 | 20.1 | 22.3 | 22.1 | 19 | 13.8 | 9 | 4.6 |
| Min. Temperature (°C) | -1.2 | -0.2 | 2.3 | 6.9 | 11.6 | 15.6 | 17.6 | 17.4 | 14.2 | 9.8 | 5.3 | 1.5 |
| Max. Temperature (°C) | 5.3 | 6.3 | 9.1 | 14.8 | 19.7 | 24.7 | 27 | 26.8 | 23.8 | 17.9 | 12.8 | 7.8 |
| Avg. Temperature (°F) | 35.6 | 37.4 | 42.3 | 51.4 | 60.1 | 68.2 | 72.1 | 71.8 | 66.2 | 56.8 | 48.2 | 40.3 |
| Min. Temperature (°F) | 29.8 | 31.6 | 36.1 | 44.4 | 52.9 | 60.1 | 63.7 | 63.3 | 57.6 | 49.6 | 41.5 | 34.7 |
| Max. Temperature (°F) | 41.5 | 43.3 | 48.4 | 58.6 | 67.5 | 76.5 | 80.6 | 80.2 | 74.8 | 64.2 | 55.0 | 46.0 |
| Precipitation / Rainfall (mm) | 43 | 33 | 35 | 47 | 43 | 47 | 44 | 33 | 42 | 41 | 61 | 56 |

# HAMBURG WEATHER BY MONTH // WEATHER AVERAGES

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | -0.2 | 0.2 | 3.5 | 7.8 | 12 | 15.3 | 17.3 | 17 | 13.9 | 9.1 | 4.8 | 1.6 |
| Min. Temperature (°C) | -2.6 | -2.6 | -0.3 | 3 | 6.6 | 9.9 | 12.2 | 11.9 | 9.1 | 5.4 | 2.3 | -0.6 |
| Max. Temperature (°C) | 2.3 | 3.1 | 7.3 | 12.6 | 17.5 | 20.7 | 22.4 | 22.1 | 18.8 | 12.9 | 7.3 | 3.9 |
| Avg. Temperature (°F) | 31.6 | 32.4 | 38.3 | 46.0 | 53.6 | 59.5 | 63.1 | 62.6 | 57.0 | 48.4 | 40.6 | 34.9 |
| Min. Temperature (°F) | 27.3 | 27.3 | 31.5 | 37.4 | 43.9 | 49.8 | 54.0 | 53.4 | 48.4 | 41.7 | 36.1 | 30.9 |
| Max. Temperature (°F) | 36.1 | 37.6 | 45.1 | 54.7 | 63.5 | 69.3 | 72.3 | 71.8 | 65.8 | 55.2 | 45.1 | 39.0 |
| Precipitation / Rainfall (mm) | 59 | 42 | 52 | 46 | 56 | 71 | 78 | 79 | 64 | 58 | 63 | 70 |

# WARSAW WEATHER BY MONTH // WEATHER AVERAGES

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | -3.5 | -2.7 | 1.5 | 7.9 | 13.3 | 16.8 | 18.2 | 17.4 | 13.3 | 8.5 | 3.1 | -1.1 |
| Min. Temperature (°C) | -6.2 | -5.6 | -2.2 | 3 | 7.9 | 11.5 | 12.9 | 12.1 | 8.6 | 4.5 | 0.6 | -3.4 |
| Max. Temperature (°C) | -0.8 | 0.3 | 5.2 | 12.9 | 18.7 | 22.2 | 23.5 | 22.8 | 18.1 | 12.5 | 5.7 | 1.2 |
| Avg. Temperature (°F) | 25.7 | 27.1 | 34.7 | 46.2 | 55.9 | 62.2 | 64.8 | 63.3 | 55.9 | 47.3 | 37.6 | 30.0 |
| Min. Temperature (°F) | 20.8 | 21.9 | 28.0 | 37.4 | 46.2 | 52.7 | 55.2 | 53.8 | 47.5 | 40.1 | 33.1 | 25.9 |
| Max. Temperature (°F) | 30.6 | 32.5 | 41.4 | 55.2 | 65.7 | 72.0 | 74.3 | 73.0 | 64.6 | 54.5 | 42.3 | 34.2 |
| Precipitation / Rainfall (mm) | 22 | 23 | 25 | 33 | 53 | 67 | 71 | 58 | 43 | 35 | 39 | 32 |

# DUBAI WEATHER BY MONTH // WEATHER AVERAGES

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | 18.6 | 19.3 | 22.4 | 25.4 | 29.5 | 32 | 34.1 | 34.2 | 32 | 28.4 | 24.1 | 20.8 |
| Min. Temperature (°C) | 13.2 | 14 | 16.8 | 19.3 | 23 | 25.7 | 28.5 | 28.5 | 25.6 | 22 | 17.6 | 15 |
| Max. Temperature (°C) | 24.1 | 24.6 | 28 | 31.6 | 36 | 38.3 | 39.8 | 40 | 38.4 | 34.9 | 30.6 | 26.6 |
| Avg. Temperature (°F) | 65.5 | 66.7 | 72.3 | 77.7 | 85.1 | 89.6 | 93.4 | 93.6 | 89.6 | 83.1 | 75.4 | 69.4 |
| Min. Temperature (°F) | 55.8 | 57.2 | 62.2 | 66.7 | 73.4 | 78.3 | 83.3 | 83.3 | 78.1 | 71.6 | 63.7 | 59.0 |
| Max. Temperature (°F) | 75.4 | 76.3 | 82.4 | 88.9 | 96.8 | 100.9 | 103.6 | 104.0 | 101.1 | 94.8 | 87.1 | 79.9 |
| Precipitation / Rainfall (mm) | 17 | 28 | 13 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 16 |

# SINGAPORE WEATHER BY MONTH // WEATHER AVERAGES

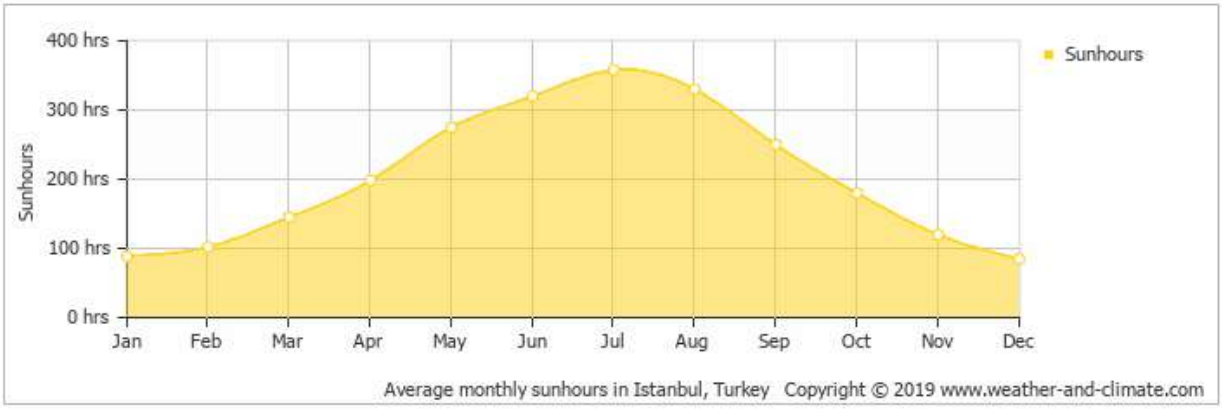
| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | 26.1 | 26.6 | 26.9 | 27.2 | 27.4 | 27.3 | 27.1 | 26.9 | 26.9 | 27 | 26.6 | 26.1 |
| Min. Temperature (°C) | 22.3 | 22.6 | 22.8 | 23.2 | 23.6 | 23.6 | 23.3 | 23.2 | 23.1 | 23 | 22.8 | 22.5 |
| Max. Temperature (°C) | 29.9 | 30.6 | 31.1 | 31.3 | 31.3 | 31.1 | 30.9 | 30.7 | 30.8 | 31 | 30.4 | 29.7 |
| Avg. Temperature (°F) | 79.0 | 79.9 | 80.4 | 81.0 | 81.3 | 81.1 | 80.8 | 80.4 | 80.4 | 80.6 | 79.9 | 79.0 |
| Min. Temperature (°F) | 72.1 | 72.7 | 73.0 | 73.8 | 74.5 | 74.5 | 73.9 | 73.8 | 73.6 | 73.4 | 73.0 | 72.5 |
| Max. Temperature (°F) | 85.8 | 87.1 | 88.0 | 88.3 | 88.3 | 88.0 | 87.6 | 87.3 | 87.4 | 87.8 | 86.7 | 85.5 |
| Precipitation / Rainfall (mm) | 250 | 166 | 181 | 187 | 166 | 164 | 166 | 180 | 163 | 195 | 262 | 298 |

# SHANGHAI WEATHER BY MONTH // WEATHER AVERAGES

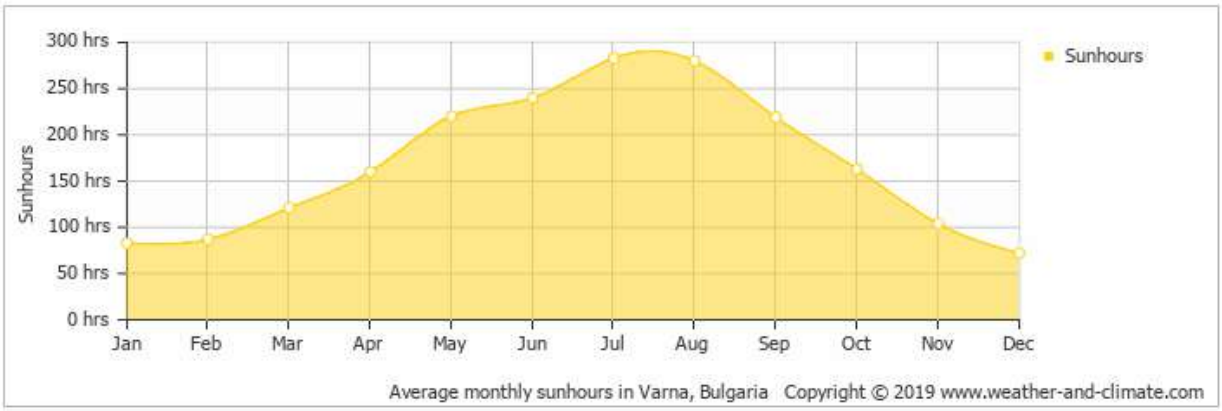
| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avg. Temperature (°C) | 4.3 | 4.9 | 8.8 | 14.4 | 19.4 | 23.5 | 28 | 27.9 | 23.9 | 18.6 | 12.8 | 6.9 |
| Min. Temperature (°C) | 0.8 | 1.5 | 5.2 | 10.5 | 15.6 | 20.1 | 24.6 | 24.5 | 20.5 | 14.9 | 8.9 | 2.9 |
| Max. Temperature (°C) | 7.8 | 8.4 | 12.5 | 18.3 | 23.3 | 27 | 31.5 | 31.4 | 27.3 | 22.4 | 16.8 | 10.9 |
| Avg. Temperature (°F) | 39.7 | 40.8 | 47.8 | 57.9 | 66.9 | 74.3 | 82.4 | 82.2 | 75.0 | 65.5 | 55.0 | 44.4 |
| Min. Temperature (°F) | 33.4 | 34.7 | 41.4 | 50.9 | 60.1 | 68.2 | 76.3 | 76.1 | 68.9 | 58.8 | 48.0 | 37.2 |
| Max. Temperature (°F) | 46.0 | 47.1 | 54.5 | 64.9 | 73.9 | 80.6 | 88.7 | 88.5 | 81.1 | 72.3 | 62.2 | 51.6 |
| Precipitation / Rainfall (mm) | 44 | 56 | 73 | 87 | 91 | 168 | 138 | 134 | 133 | 53 | 49 | 40 |

# Average monthly hours of sunshine over the year

This is the monthly total of sunhours









**Note:** Data collected from: https://en.climate-data.org/ & https://weather-and-climate.com

*Figure 20 – Bulgaria Shipyard Area – High humidity and foggy days around October – November*

The above example is given for a Bulgaria Shipyard Area. 15 – 20 days of the month can be foggy in the region, affecting repair activities (docking, coating, etc.). Also, it can affect the flights of the region (technician & material supplies).

14. **Suggestions from third parties (Consultancy Companies, Class Societies (unofficially), Agencies, Manufacturer Companies):** These items are related to the yard's background and experiences on that yard project. If you want to learn more about Turkish Shipyards for new building, repair, or conversion, please don't hesitate to contact us. (faruka@efesmarine.com.tr).

15. **Language of the country – worker hospitality – safe to stay out of shipyard – hotel arrangements:** Communication in the yard area is important for safety, work quality, etc. So, minimum yard supervisors and engineers must communicate with the vessel team easily. Projects are 24-hour periods where you are away from your house. Relationships with yard teams and vessel teams indirectly affect the groups' psychology and the project's quality.

During the repair period, the team must have reasonable hotel options (third parties, etc.) Transportation between hotels (also as yard accommodation places) and yards must be safe, quick, and comfortable. In the Tuzla area, around 2 km. range, there are ~15 hotels for superintendents and technicians, which means all teams will have a chance to rest. It is also easy to manage transportation even by walking range. Prices are also cost-effective if compared with any EU or other locations background and experiences on that yard project. If you want to learn more about Turkish Shipyards for new building, repair, or conversion, please don't hesitate to contact us. (solution@marineindustry.net).


*Figure 21 - Hotels Nearby Location – Tuzla Shipyard Area (2 km range) (Double Tree Hilton, Holiday Inn, Radisson Blue, Ibis Hotel, Green Park etc.) – Prices levels are generally below 100 Euro/night*

16. **Shipyard marketing department activities:** Customer visits can affect the owner so much for initial meetings. Strong marketing executives can earn many projects with a standard quotation. However, the marketing department's duties are just for "welcome projects" and collecting feedback during the projects. After that, the yard production and planning team is responsible for all responsibilities, which means "Action Time." In some cases, this item can have higher priority.

17. **Yard docking availability:** For last-minute repairs, urgent situations, or after last-minute cancellations of chartering departments, etc., owners are looking for a yard just available for their vessel. In addition, some owners are looking for yard slots to reduce the prices and total budget at the last minute. In any case, we can think of this item as a gambling option. If you are lucky, you can earn, but if not, "good luck." Sometimes, yards cannot tell their customer "NO" even if they are fully booked. In that case, the ship owner must accept many shifting operations for their vessel and delays.

18. **Reachable approved service suppliers, technicians, workshops, and classification societies:** Strong yard areas can manage most of their work in-house (in a shipyard or nearby workshops/partners). Suppose a ship-owner selects a shipyard in one of the strategic yard areas. In that case, their cost for technician and material logistics, hotels, travel costs from class, service technicians, etc., will be less than other points. In addition, last-minute items can be managed easily; if there are some delays, it will not create additional daily charges, etc.


*Figure 22 - IACS Members*

For worst-case scenarios (like a pandemic, flight restrictions, etc.), ship owners will not be affected due to missing technicians, or even they can reach local superintendents. Also, about service suppliers, they have local contact or workshops in nearby shipyard locations. Even if a manufacturer representative has yet to have a chance to attend to the vessel, there can be strong and trained local subcontractors.

All IACS members (DNV GL, NK, BV, TL, ABS, RINA, RMS, LR, KR, etc.) paint manufacturers (Chemco International, Jotun, Hempel, International, Chugoku, Marineline, etc.), major service suppliers or workshops (Siemens, MAN, CAT, Alfa Laval, Wartsila, etc.) are in 1 – 20 km range for Istanbul Tuzla Shipyard Area (For Yalova 1 – 60 km). These items are affecting the cost of repair so much that the ship owners are not paying more for travel or waiting costs.

19. **Shipyard marketing department activities:** Customer visits can affect the owner so much for initial meetings. Strong marketing executives can earn many projects with a standard quotation. However, the marketing department's duties are just for "welcome projects" and collecting feedback during the projects. After that, the yard production and planning team is responsible for all responsibilities, which means "Action Time." In some cases, this item can have higher priority.

20. **Quantity of shipyards in region:** As a simple mentality, more options for ship owners means competitive repair prices. More shipyards in the region also significantly improve the subcontractor quality and experience. More options can help the owner for solving complicated problems. Also, subcontractors are stronger in those regions, and it is easier to solve daily issues just in time.


*Figure 23 - Tuzla & Yalova Shipyard Areas*

*Table 4 - Istanbul Region Shipyard Docks(5 km range)*

| No | City | Shipyard Name | Dock Type | Dimensions |
|---|---|---|---|---|
| 1 | İSTANBUL / TUZLA | ART SHIPYARD | Floating Dock | 230x38 m |
| 2 | İSTANBUL / TUZLA | ART SHIPYARD | Floating Dock | 180x35,5 m |
| 3 | İSTANBUL / TUZLA | ÇEKSAN GEMİ İNŞA ÇELİK KONS. SAN. ve TİC. A.Ş. | Floating Dock | 145x21,5 m |
| 4 | İSTANBUL / TUZLA | DENTAŞ - ÇİNDEMİR MAKİNE GEMİ ONARIM ve TERSANECİLİK A.Ş. – EOS GROUP | Floating Dock | 146x23 m |
| 5 | İSTANBUL / TUZLA | DENTAŞ İNŞA ve ONARIM SAN. A.Ş. EOS GROUP | Floating Dock | 190x34 m |
| 6 | İSTANBUL / TUZLA | DENTAŞ İNŞA ve ONARIM SAN. A.Ş. EOS GROUP | Floating Dock | 225x39 m |
| 7 | İSTANBUL / TUZLA | DENİZ ENDÜSTRİSİ A.Ş. | **Dry Dock** | 210x37 m |
| 8 | İSTANBUL / TUZLA | DESAN DENİZ İNŞAAT SANAYİ A.Ş. | Floating Dock | 177x29 m |
| 9 | İSTANBUL / TUZLA | DESAN DENİZ İNŞAAT SANAYİ A.Ş. | Floating Dock | 145x25 m |
| 10 | İSTANBUL / TUZLA | DESAN DENİZ İNŞAAT SANAYİ A.Ş. | Floating Dock | 234x41 m |
| 11 | İSTANBUL / TUZLA | TK TUZLA – ERKAL ULUSLARARASI NAKLİYAT ve TİCARET A.Ş. | Floating Dock | 350x65 m |
| 12 | İSTANBUL / TUZLA | GEMAK - TUZLA GEMİ ENDÜSTRİSİ A.Ş. – TGE | **Dry Dock** | 300x53 m |
| 13 | İSTANBUL / TUZLA | GEMAK GEMİ İNŞAAT SANAYİ ve TİC.A.Ş. | Floating Dock | 245x37 m |
| 14 | İSTANBUL / TUZLA | GEMAK GEMİ İNŞAAT SANAYİ ve TİC.A.Ş. | Floating Dock | 200x32 m |
| 15 | İSTANBUL / TUZLA | HİDRODİNAMİK GEMİ SAN. ve TİC. A.Ş. | Floating Dock | 130x16 m |
| 16 | İSTANBUL / TUZLA | KUZEYSTAR SHIPYARD | Floating Dock | 229x36 m |
| 17 | İSTANBUL / TUZLA | KUZEYSTAR SHIPYARD | Floating Dock | 298x52 m |
| 18 | İSTANBUL / TUZLA | TORLAK SHIPYARD | Floating Dock | 196x32 m |
| 19 | İSTANBUL / TUZLA | SEDEF GEMİ İNŞAATI A.Ş. | **Dry Dock** | 310x50 m |
| 20 | İSTANBUL / TUZLA | TERSAN TERSANECİLİK ve TAŞIMACILIK SAN. ve TİC. A.Ş. | Floating Dock | 130x22,5 m |

*Table 5 - Yalova Region Shipyard Docks (7 km range)*

| NO | City | Shipyard Name | Dock Type | Dimensions |
|---|---|---|---|---|
| 1 | YALOVA | BEŞİKTAŞ SHIPYARD | Floating Dock | 227x37 m |
| 2 | YALOVA | BEŞİKTAŞ SHIPYARD | Floating Dock | 382x58 m |
| 3 | YALOVA | BEŞİKTAŞ SHIPYARD | **Dry Dock** | 235x40 m |
| 4 | YALOVA | DOĞRUYOL TERSANECİLİK SAN. ve TİC.A.Ş. | Floating Dock | 123x30 m |
| 5 | YALOVA | HAT-SAN GEMİ İNŞAA BAKIM-ONARIM DEMİR NAK. SAN. ve TİC. A.Ş. | Floating Dock | 180x30 m |
| 6 | YALOVA | HAT-SAN GEMİ İNŞAA BAKIM-ONARIM DEMİR NAK. SAN. ve TİC. A.Ş. | Floating Dock | 250x38 m |
| 7 | YALOVA | HAT-SAN GEMİ İNŞAA BAKIM-ONARIM DEMİR NAK. SAN. ve TİC. A.Ş. | Floating Dock | 250x38 m |
| 8 | **ÇANAKKALE** | İÇDAŞ SHIPYARD | Dry Dock | 370x70 m |
| 9 | YALOVA | SEFİNE DENİZCİLİK TERSANECİLİK TURİZM SAN. ve TİC. A.Ş. | **Dry Dock** | 240x42 m |
| 10 | YALOVA | SEFİNE DENİZCİLİK TERSANESİ SAN. ve TİC. A.Ş. | Floating Dock | 280x47 m |
| 11 | YALOVA | SELTAS SHIPYARD | Floating Dock | 260x45 m |
| 12 | YALOVA | TERSAN TERSANECİLİK SAN ve TİC AŞ | Floating Dock | 180x29 m |
| 13 | YALOVA | TERSAN TERSANECİLİK SAN ve TİC AŞ | Floating Dock | 310x51 m |
| 14 | YALOVA | ÖZATA SHIPYARD | Floating Dock | 252x43 m |
| 15 | YALOVA | ÖZATA SHIPYARD | Floating Dock | 184x27 m |
| 16 | YALOVA | PARK SHIPYARD | Floating Dock | 227x37 m |

21. **Time difference:** Vessel repair is always related to third parties like service suppliers, material suppliers, charterers, ship-owner offices, and yards. The vessel will be in one shipyard area, but decisions, supplies, and mail will continue to be received and sent worldwide. For this reason, optimum locations need to be selected by a ship-owner representative to manage all those scenarios.

22. **New building activities in the region:** If the vessel is built where repair yards are also located, it will be easy to repair or supply related spares or easy to reach repair quality with new building standards.

23. **Yard quotation comparisons with other yards' marketing departments:** Some owners wish to crosscheck the prices with yards' marketing departments by sharing other yards' offers, but that is not fair. All yards have quotation systems with some standards, and country regulations and technologies significantly affect that quotation system. These standards are developed with RD, experience, and engineering methods. So, for the owner side, if they wish to be fair to yards, they can cross the items internally with their team, and just for some items, they can discuss with the yards. Compared with the yards, marketing departments can cause additional costs for future projects to the owner.

24. **Safety of the country & justice in the location:** The vessel crew, superintendents, or specialists must feel secure in the country where the repair is carried out. Owners must feel confident about the contracts.

25. **Pandemic:** Up to 2020, the pandemic was a local problem for some countries, not affecting global commerce so much. But with COVID-19, the world understands we have no backup plan to survive. As ship-owners or representatives, nowadays, we need to decide the location of the shipyard, where we can receive trustful information, have strong health systems, and have manageable safety/health precautions against the pandemic.

In addition, for unexpected lockdowns or precautions, ship owners need to find local partners in advance (If required) who can have enough experience to manage their repairs (turnkey), local service requirements, or local third-party organizations in good order.

26. **Lockdown–strike records:** The ship-owner representative needs to request lockdown periods of yards from the shipyard representative, make a crosscheck from the local embassy, etc. Lockdowns due to pandemics or strikes because of worker rights, salaries, or country safety can block all the projects suddenly. In this case, sometimes, ship-owner companies must decide to leave the shipyard during the repair period so as not to block the vessel in the dock or berth.

27. **Custom and visa availability:** During the repair periods, there will be team and equipment transfers for vessels. For that kind of work scopes, agents, customs officers, or visa applications must be done quickly with minimum bureaucracy. In Turkey, agents are familiar with marine business from 2 to 24 hours. All ships in transit or other customs works can be completed without problem.

28. **Location of the yard (Tourism – Gastronomy etc.):** That item is not critical for short-term repair periods. During the conversion projects or above one month's repair projects, crews, superintendents, or other parties must save their family relations. During the repair period, the vessel team & superintendent can invite their families for short-term (5 – 7 days) trips on weekends or after working hours on weekdays. Their families can make some city tours during the weekday by themselves, and in the evening, all the family can enjoy being together. This mentality can reduce the team members' stress and improve their relationship with their families.

*Figure 24 - Turkish Baklava with Pistachios*

**Writer Suggestion:** As a history lover, I am happy to say that Istanbul is the capital city of history. Because of its composition, location, and more, the last ~9000 years of proven record, it was always a famous and essential location for all countries.

As a tourist, you could feel the voice of azan, church bell, synagogue, or more with peace of religions, cultures, and peoples. Due to its climate, strategic location, mixture of culture, and history of commercial and city activities, Istanbul can be a nearly unique location for Mid–West Asia, Africa, Europe, and America for most human beings.

In the last 3000 years, commercial ways from China to Europe (East to West) and Egypt to Italy (South to North) have passed through to Istanbul. It is not just connecting the continents also. It is the unique city in the world that has had a chance to save its important positions for nearly the last 5000 years.

http://www.3dmekanlar.com/en/3d-istanbul.html

http://howtoistanbul.com/

29. **BONUS – Green shipyard mentality:** Now, shipyards are trying to follow some green yard application processes to save people and the environment together. Some major works like hull blasting can change with water jetting systems that can also collect the existing paint residues and, with some extra precautions, reduce the overspray paint percentages to minimum levels. In addition, yards can & may use ballast water treatment systems for docking & undocking operations.

Figure 25 - Treating of Washing Waters

Disposal of sludge, contaminated materials, and electronic equipment with approved recycling companies with a proper method can also be an option.

Asbestos-free applications are well-known yard repair practices, and yards can give ship-owners an “Asbestos Free Declaration” for their repair work.

Using water jetting technology on the hull for surface preparation will be another selection criterion for the yard. Nowadays, water jetting technology speed and coating product qualities are more than enough for surface preparation and vessel corrosion protection. Also, vacuum systems can filter washing water to reduce pollution and human footprint.

Currently, hull treatment system efficiencies are 50 – 90 m²/h with a machine. In addition to that, magnetic crawler systems can also be used for hull surface preparations. The most significant benefits of water jetting systems are;

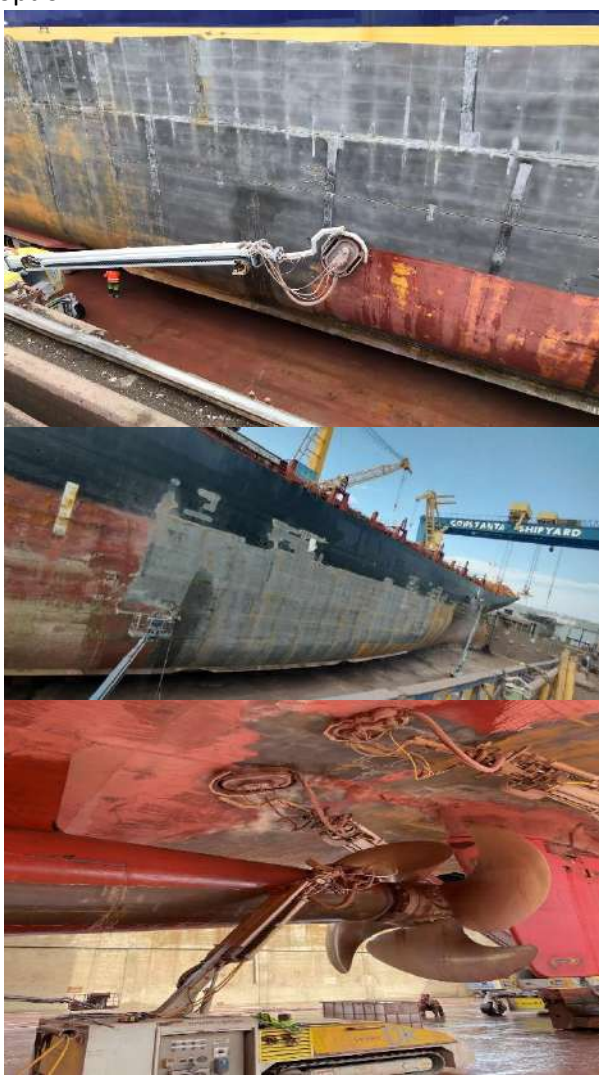


Figure 26 - Waterblasting with Robotic Systems

- No air pollution because of dust etc.,
- Contaminated water can be collected and treated during the surface preparation,
- No need two steps (washing & grid blasting),
- All paint manufacturers have standard epoxies and surface tolerant systems, and even with silicon paint systems, it can be possible to apply,
- Shaft – hull repairs or even deck repairs can be managed simultaneously with hull treatment,
- For silicon applications, water blasting can reach around 5.000 - 10.000 m²/day (SA2 – WJ1) surface quality with robots, and it will not create any additional risks.

Figure 27 - Water blasting with Magnetic Crawlers or Surface Robots

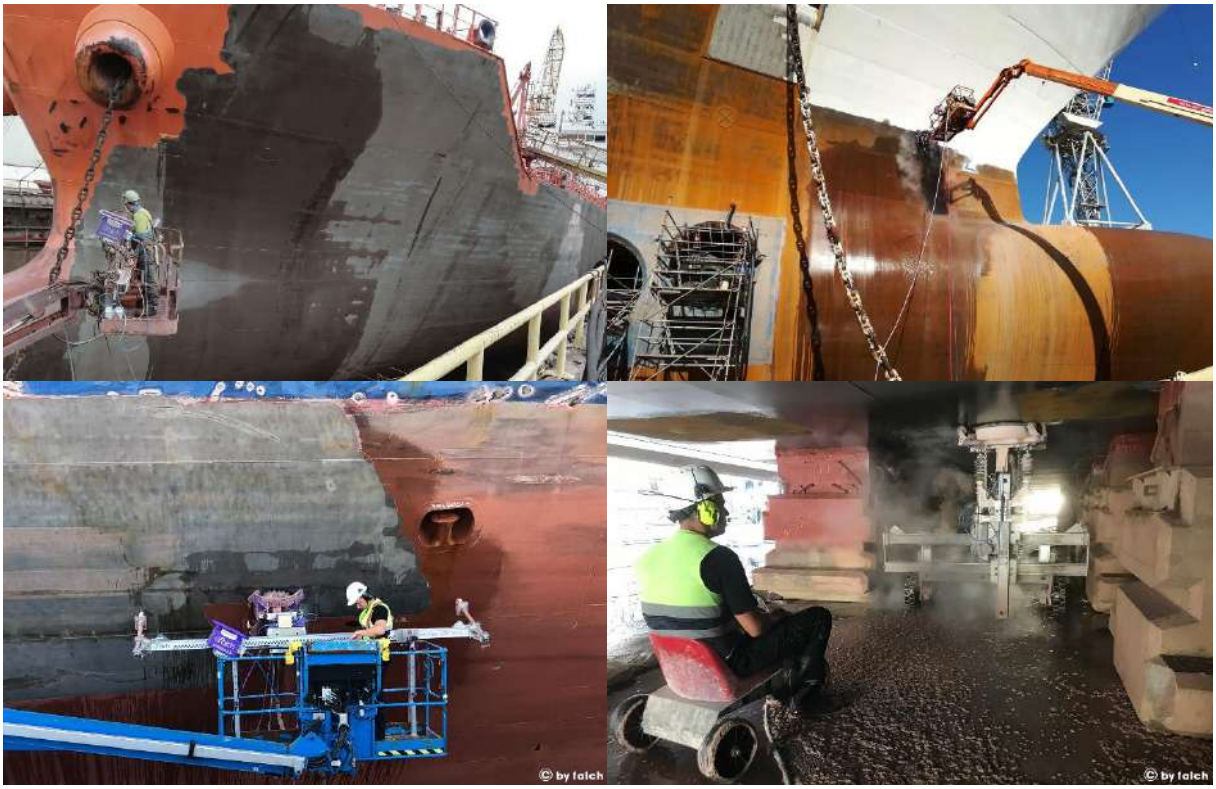



Figure 28 - Falch Robots for Ship Waterblasting

30. **BONUS –DISCRIMINATION AGAINST WOMEN WORKERS:** One of the weakest points of our marine industry is the lack of women labor in the field. There are so many areas where women can work (As welders, painters, cleaners, crane operators, engineers – managers, superintendents, etc.), but again, the domination of men is against that mentality. That item may not be the selection criteria. Still, after selecting a yard, ship-owners can push the yard management to encourage recruiting more women workers even with higher salaries or better working hours. Now ~99% of the companies have less than 1% women workers on the field, so as a customer, owners can push, not just for yards but also the service suppliers, ship chandlers, engineering companies, etc., to recruit more women workers (not just for office) in short, mid, long-term periods.

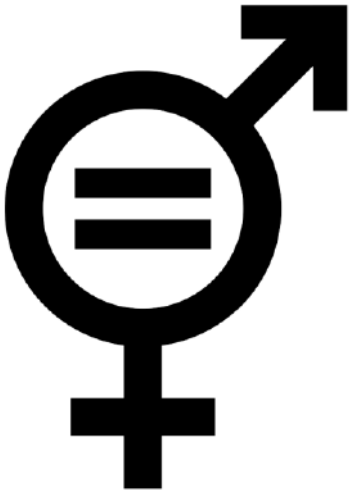


*Figure 29 - Gender Equality*

31. **BONUS – POSITIVE DISCRIMINATION AGAINST LGBTQIA:** Up to now, LGBTQIA people are invisible in our industry. Onboard or onshore, all concessions are against accepting the world's reality. Companies need to encourage the communities to save the human right to freedom.

*Figure 30 - Equality*

32. **BONUS – GREENHOUSE GAS EMISSIONS:** During the manufacturing process, our yards use huge amounts of electrical energy, consumables, grid materials, etc. Shipyards have a chance to convert some of their traditional production methods to innovative solutions (grid blasting to water blasting, new technology – efficient welding machines, solar energy usage for their production, etc.). Some shipyards are trying to follow the Paris Climate Agreement goals for our environment. As a shipowner, that item can also be a rewarding way of shipyards.


*Figure 31 - Solar Energy Usage at Shipyard (Tersan Shipyard)*

33. **UNSPOKEN AGENDA – BRIBERY AND CORRUPTION:** During the repair activities, several works can be controlled onboard with the vessel team and need to be discussed with the yard at the location. If the shipyard has a detailed quotation system in advance and during the repair period, the shipowner and superintendent can stay safe if they can properly manage the "work done" system. The initial quotation must have options for additional work during the repair periods. That way, the owner's office team can agree on unit prices in advance. During the repair period, quantities (areas, weights, lengths, etc.) can be cross-checked with the vessel crew and the superintendent. Engine works "work done" can be followed via the Chief Engineer's team, and the Master's team can follow deck works.

*Figure 32 - Bribery and Corruption*

Steelworks, pipework, and outfitting works, work scope, and sizes can be clarified with yard teams, and the yard design department can prepare all initial designs before starting any related job. After completion of those works, final drawings can be prepared by the yard design department so the owner team can cross-check all repaired areas one by one with the vessel team. Those documents can help the office teams cross-check if any items are missing.

If a shipowner has a chance to find a well–known, reputable shipyard, the risks of bribery can be less. Shipyards can have higher prices (because they have some segregated teams for design, R&D, engineering, etc.), but the shipowners can be safe.

About service companies, audits of approved workshops are critical. So many companies worldwide say they can do everything (which means nothing), so specialized companies for segregated works are the key point of service suppliers or consultancy companies. If owners decide to use consultancy companies, then they have to check the CVs of company employers, the official daily worker list from the government, certificates about their proficiency, and equipment park & workshop control for related works are also critical.

**"IMO Guidance to address bribery and corruption in the maritime sector"** and organizations like https://macn.dk/ are trying to find a way to solve that problem, which is affecting the business and crew lives.

**SHIPOWNERS CAN MAKE THE AGREEMENTS DIRECTLY WITH YARDS. NO THIRD PARTY, NO AGENCY, NO FARUK, HANS, KOSTAS, JEN, JULIA, ALEX… NO TO BROKERS!**

**FOR EFES MARINE DECLERATIONS & POLITICS.**

## Section 2.03 Documentation for Yard Entrance and Yard Initial Day

After confirmation – and selection of yard offers – quotation, the yard must collect vessel data from the ship-owner side. For docking arrangements, some drawings are needed initially.

- **Capacity Plan**
- **Mid-ship Section**
- **Docking Plan**
- **Weight Distribution**
- **Construction Plan** (echo sounder, speed log, bottom plug, seachest locations, etc.),
- **HAZMAT Report** (The ship-owner must share updated reports to the shipyard for repair plans.) (The yard must arrange a plan for hazardous material removal if needed.)

Drafts of the vessel must be sent to the shipyard with clear explanations if the ship has special construction or works (even the possibility of work scope, shaft removal, etc.) that must be clarified at the beginning.

Also, shaft withdrawal information must be shared in advance for safe docking (inside the engine room or outside).


Figure 33 - Vessel Accommodation Preparations for Docking

**Remember:** Ship repair is a challenging environment to work in. Yards are changing, and teams that are working in that environment are also changing day by day. Existing ship repair experience in one location may be different for the next repair. So, the ship-owner team needs to be careful about each repair if they have no updated information about the yard or teams.

Before arrival at the shipyard, the vessel team must prepare corridors and meeting rooms for dirty shoes and overalls. Yard repair teams, service technicians, etc., are to be on board for all items, and with a limited time frame, it is very hard to find a solution for precautions. If the vessel team does not follow minor protections, there may be additional costs for linoleum or chair fabrics, etc.

### (a) Initial day meeting & daily meetings for repair works

#### *(i) Initial day meeting – first meeting with yard*

When the vessel enters the yard area on the first day, the vessel's superintendent attends the ship, and he/she must complete the last checks with the vessel crew for confirmation of work orders to the yard or third parties. After quick checks, the yard team (Project Manager – Estimator – Project Engineer) and vessel team (Superintendent – Master – Chief Engineer) must confirm (cancel, after inspection, etc.) the yard offer – quotation list items one by one. Marketing departments of the yards are sharing the quotations with standard prices and as per limited clarification by ship-owner representatives. Superintendents must decide which items need to be done (Confirmed items), which items need to be canceled (Cancelled items), and which items need to be clarified later (After inspection). After clarification of confirmed and canceled works, the yard can arrange their team and update the project's planning. After inspection, items must be clarified as soon as possible with inspections, class, maker suggestions, etc. These items must be checked one by one during the daily meetings so as not to create delays.

After the “Initial Day Meeting,” the shipyard can update the project's scope and budget. After that budget update, the ship-owner has updated the budget, and they can decide on additional work or repairs if needed. Revised budgets are one of the critical items for the repair period. Unit price items (steelwork, staging, pipe works, coating areas, etc.) can change the budget to incredible levels if initial calculations or inspections aren't completed properly. Of course, third parties may have a chance to change the scope of the work. For, During the tank inspections class, society can suggest renewing coating for CAP surveys, or the chain measurement report may show some length chain renewals need to be done or some stern tube damages or main engine bearing damages can be seen during the routine inspection.

In the first 5 days, the yard must update the initial quotation – offer and share it with the vessel superintendent via mail and as a hard–soft copy. In that way, all parties can see their budget, schedule, and additional work opportunities during the project.

### *(ii) Daily meetings*

These daily meetings are critical for all parties to follow the work scope, quickly respond to urgent items, and see all significant parts of the project.

*Table 6 - Attender of Daily Meeting & Topics*

| Time | Description | Vessel Team | Yard Team |
|---|---|---|---|
| 08:00 – 08:15 | Vessel work scope (Internal) | C, SI, CO, CE, 2E, EL, SO, BO | - |
| 08:00 – 08:30 | Yard team inspection, controls, and work orders (Internal) | - | PM, PE, ES, F, YS |
| 08:00 – 09:20 | Repair works (Yard & vessel routine) | - | - |
| **09:30 – 09:35** | Daily safety meeting | C, SI, CO, CE, SO, EL, TP | PM, PE, YS, F |
| **09:35 – 09:50** | Deck & docking works | C, SI, CO, CE, SO, EL, TP | PM, PE, F |
| **09:50 – 10:00** | Engine & mechanical & docking & electrical works | C, SI, CO, CE, SO, EL, TP | PM, PE, F |
| 10:00 – 10:15 | Coffee time – Additional Works – Detail discussions – (If needed) | SI, TP* (If needed) | PM*, ES*, F |
| 10:15 – 10:45 | Supplies or Class Meeting* | SI, C*, CE*, CO, SC, CS* | PE*, PM* |
| 13:00 – 14:00 | Supplies | SI, C*, CE*, CO, SC | PE* |
| 16:00 – 16:15 | Daily Completion Meeting * | SI, C*, CO*, CE* | PM*, PE, ES* |
| 16:15 – 18:00 | Daily vessel inspection, reports, quotations, and work orders | SI, C*, CO*, CE* (Internal) | PM, PE, ES (Internal) |

**C**: Captain **SI**: Superintendent **CO**: Chief Officer **CE**: Chief Engineer
**EL**: Electrician **BO**: Bosun **SO**: Safety Officer **PM**: Project Manager **PE**: Project Engineer
**ES**: Estimator **YS**: Yard Safety Officer **F**: Foreman (Steel, Pipe, Mechanical etc.) *: Optional
**TP**: Third Parties (Maker, Paint Inspector etc.) – If needed **SC:** Ship Chandler **CS:** Class Society

Only try to arrange a daily meeting on Sunday if it is the first day of docking or the last day of the ship. The ship-owner side docking is critical, but in shipyards, they have 365 days of docking. Remember, focused team efficiencies are better than stressed ones. If you think of the project manager/superintendent as coal and with pressure, it may be a diamond, but it may also start to burn, so be careful.

The **"Attendee List"** of daily meetings is given just for planning. Usually, as a standard meeting, the "Safety First" motto is always valid. Still, if there is no urgent case for safety (accident, drill, etc.), meeting items can be delayed 10 – 20 minutes more to use the engine room team more efficiently. In this way, none of the meeting members must follow unrelated items during their daily scope.

Daily meetings can also be held around 15.30 to manage tomorrow's daily work and plans. If yard PM has two vessels or different arrangements, this can be the solution for the vessel. In that way, the project engineer visits the vessel team in the morning if any updates are needed.

During the daily meeting, completed and remaining items can be explained to parties, today's work scope can be reminded to the parties, and tomorrow's and near future items can be cross-checked.

The project manager from the yard can manage the meeting with the support of the vessel superintendent. The yard team knows their resource better than other parties do, so they can also follow other projects in the yard and the relationships between projects (Docking – shifting operations, local procedures, etc.) and more. Approx. the yard managers have a chance to follow 20 – 30 projects/year and this quantity can be changed depends on yard size, project complexity etc. However, the benefits of superintendent support are that they can gain different types of docking experience in other locations, cultures, technologies, and teams. And they know their fleet better than yard engineers.

During the daily meeting, at least one member must record – and write (Daily Meeting Notes) the items, decisions, etc.; at the end of the meeting, representatives must sign those notes and share a copy with both parties.

**DON'T LET ANYBODY SMOKE IN THE MEETING ROOM DURING, BEFORE, OR AFTER THE MEETING. ALL PARTIES (SUPERINTENDENT TO MASTER, SURVEYORS TO YARD MANAGERS, ENGINEERS, AGENCY, SHIP-OWNER, OR ELSE) MUST RESPECT EACH OTHER EVEN IF IT IS PERMITTED TO SMOKE IN THE MEETING ROOM. SMOKING IN THE MEETING ROOM IS A TYPE OF MOBBING OF PROJECT PARTNERS. LET PEOPLE ENJOY FRESH AIR IN MEETING ROOMS WHERE THEY ARE STAYING TO DO THEIR JOB.**


Figure 34 – No Smoking Zone

## Section 2.04 Docking Works

Docking the vessel means making the ship free from water to manage any inspections and repairs outside of the waters. Those docking operations can be managed with floating docks, dry docks, or slipways. Generally, floating and dry docks are the best-known practice for repairs above the 100-meter length of vessels. Before starting any welding work, the ship must connect to the ground (earthing – static grounding) from the hull and rudder sides.

Figure 35 - Docking of Vessel

### (a) Initial bottom inspections (bottom plug condition survey, rudder plug opening with a witness of class surveyor etc.)

The bottom inspection can be carried out after vessel docking is completed and the water from the dock is pumped out. During that inspection, the yard and vessel team must be careful about bottom sensors (echo sounder, speed log, etc.). Bottom plugs and sea chests are clear from the keel or side blocks. In addition, damage controls must be carried out for general inspections immediately. Ship-owner and yard can save time to repair for any damages.

*Figure 36 - Speed Log & Echosounder Protection*

The vessel chief or other officer can show the yard team which bottom plugs to open. After marking, plugs are opened with a witness of the vessel team to show if there are any damages or any problems on plugs, etc., but rudder plugs cannot open during those inspections without the class surveyor.

Figure 37 - Stern Area

After the first inspection, the yard, class surveyor, and vessel team make general bottom inspections together. When the class surveyor completes the bottom inspections for general conditions and can request some NDT, etc. If required. Mostly, rudder plugs can open with a witness of the class surveyor unless otherwise specified. There can be water leakages due to condensation of gases, but if the leakages are more, it means the rudder has some holes, etc. That problem needs to be clarified and repaired by the yard. After completion of the repair, the yard must carry out a pressure test of the rudder with approved methods.

### (b) Overboard valve and seachest & filter cleanings

As a class inspection item, all overboard valves must be overhauled during the docking period. Valves are generally located in the engine room, but there can also be draft valves forepeak and in the midship section, pump room, and aft peak area.

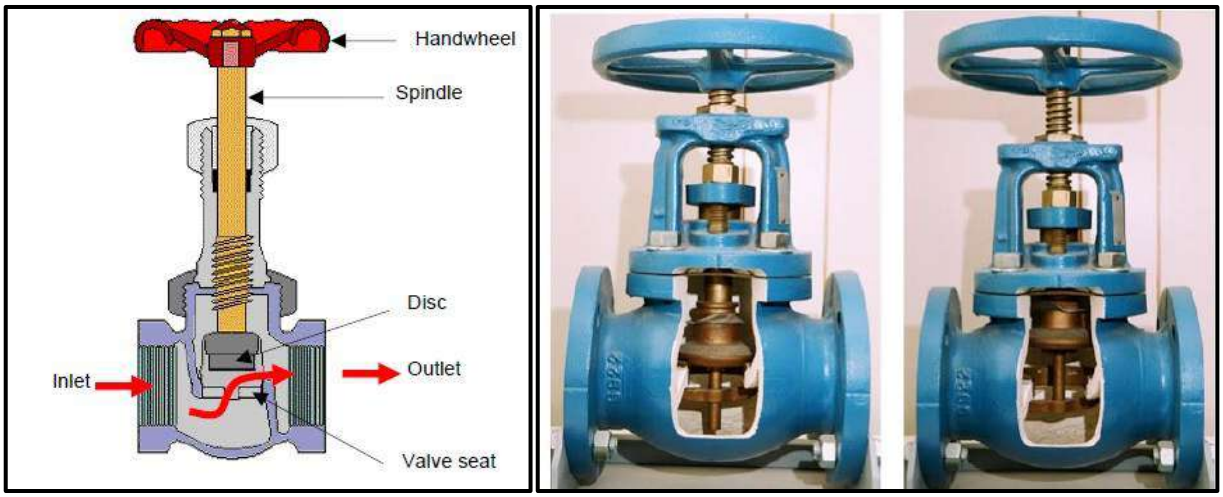



Figure 39 - Globe Valve

Most of the valves can overhauled in their location. For globe valves, most problems can be on seat and disc surfaces. Cleaning, lapping, or machining of that surface can solve that problem. Valves can be transferred to the workshop for machining and spindle fabrication works.

Figure 38 - Overboard Valve Inspections

The body surface can be coated with rust-tolerant epoxy coatings, so this will also save the valve's body. Class surveyors can check the valves visually to see the maintenance results. During the undocking operations, valves and overboard pipes can be inspected to be sure the vessel is in safe condition.

Some overboard valves can be cleaned and inspected with cherry pickers or staging. If any overboard valve needs to be renewed, the new valve needs a valid class approval certificate.

Seachests and filter cleanings can be carried out during the docking condition. Those cleanings can also affect cooling system conditions. During that period, anodes must be checked and, if necessary, renewed.

Figure 40 - Seachest Inspections

Figure 41 - ICCP Protection During the Hull Coating & Seachest Coating

If any steel renewal is carried out in sea chests, the location must be blinded with a system and tested with water (class surveyor or rules can show the pressure value) according to class rules.

### (c) Overboard pipe inspection and repairs,

Overboard pipes are pipes that are connected to the shell after overboard valves. Mostly, overboard pipes have a problem because of improper valve operations. Half openings of valves can create cavitation and corrosion inside of the pipes. In addition, inappropriate welding applications can create the same problem.

The thickness of the overboard pipes is critical (SCH80 – SCH160) for new buildings and repairs. For overboard pipe renewal works, class surveyors are very sensitive about thickness and class approval certificates for those pipes. They can also request pressure tests for leakages after fabrication. For that reason, the owner and yard must agree on which tests are required after renewal or if any approved repair methods can be carried out (epoxy repairs, PE coating repairs, welding repairs, etc.) in those locations.

Inspection can be managed from dockside with cherry picker – platforms or staging.

(For detailed information and reports, please write to us – faruka@efesmarine.com.tr)

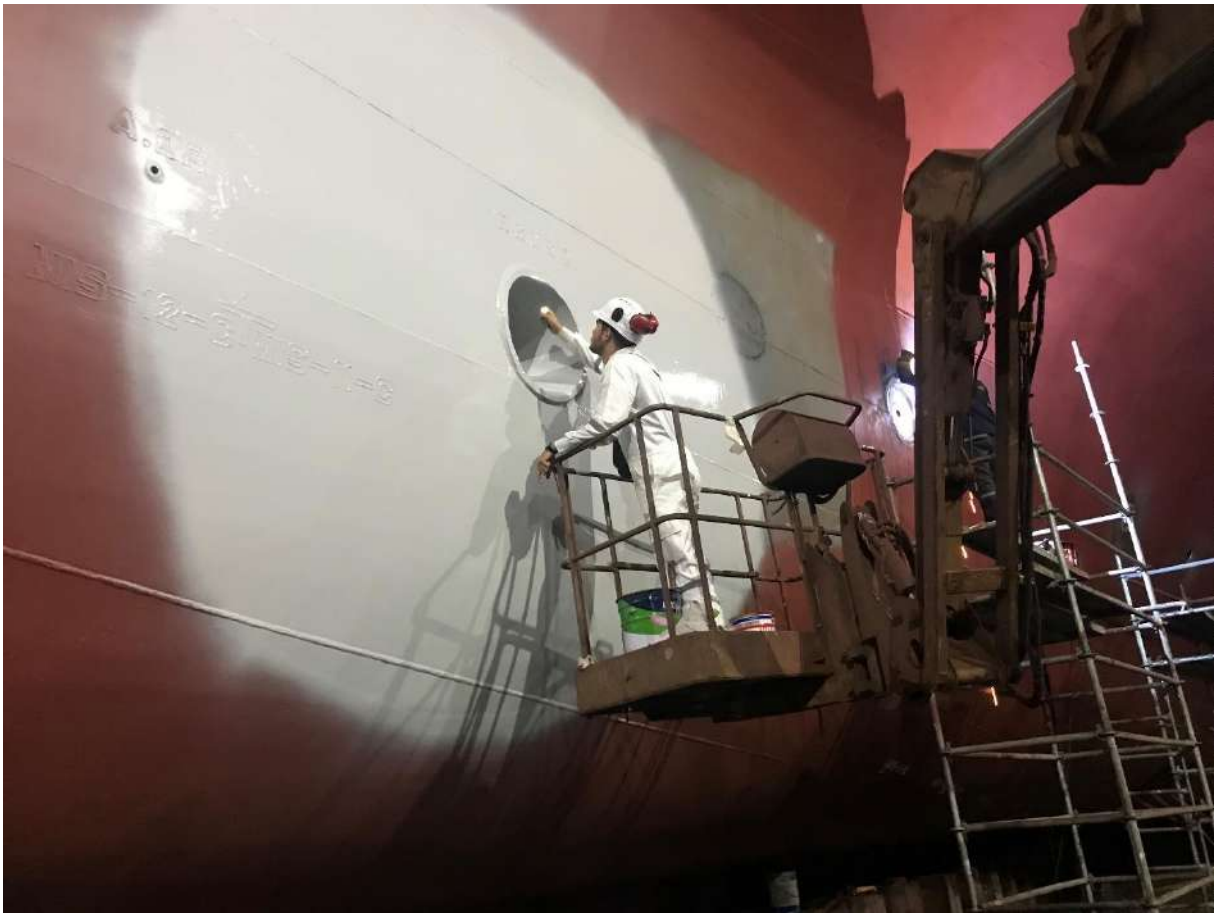


Figure 42 - Overboard Pipe Inspection (Scrubber Overboard with Glassflake RA 500M)

### (d) Hull steel works,

Hull steel works directly affect the docking period of the vessels. Hull inspections and UTM reports of the hull can show all parties the work scope for steel renewals. Changing the steel parts during the hull blasting and painting will be challenging (Waterblasting with robots can be a plus). Renewals can synchronize with hull blasting works for a small amount. Some small areas can be renewed per IACS rules, and some can be non-destructive tests. Before painting those parts, welding is tested with proper methods (tank pressurized air/water or vacuum tests, etc.). After inspection and tests, the shop-primed details must be painted per hull specifications.

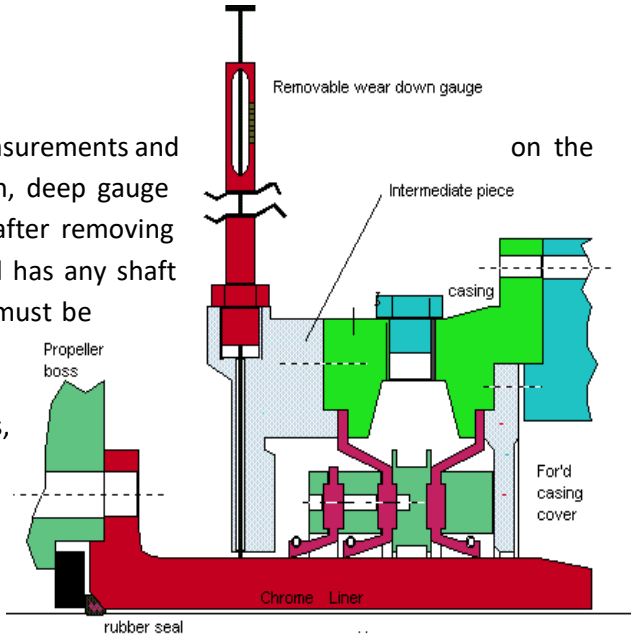
As a general suggestion, hull steelworks should be completed before coating activities. With those precautions, the hull will have a uniform coating.

Repaired areas can be painted with RS 500P Chemco products for urgent cases to reduce undocking time.


Figure 43 - Hull Steel Inserts

## (e) Shaft & propeller works,

### *(i) Shaft works*




Rope guard removal must be carried out before measurements and on the first day of the dry dock. For standard application, deep gauge (wear down) measurements must be carried out after removing the rope guard and on the first days. If the vessel has any shaft removal or seal renewal works (bonding, etc.), it must be planned together with hull coating works.

After completion of measurements and repair works, the rope guard must closed with new anodes. In addition, rope guard blades can be renewed or grind. After welding the rope guard, burned areas must be cleaned and painted at least two coats. If bolted types, fitted bolts must be welded with stainless steel stud pieces to not be removed before the next docking.

Figure 44 - Shaft Measurement

In addition to standard works, there may be some stern tube damages or renewal projects as a nightmare. Fabrication of a new stern tube can take a month from the makers, but some approved white metal application methods can be followed. In around 1 week, the superintendent can solve one of the biggest problems on the propulsion system. The white metal application must be followed as per approved procedures.

Also, some polymer-bearing solutions (Thordon, Vesconite, Ermaksan, etc.) are on your vessel and approved maker representatives must follow the installation and machining of those systems.

*Figure 45 – Stern-tube Bearings and Chrome Liner Damages*

*Figure 46 - Class Approved Re-metaling (White Metal) Application - Tersan Shipyard*

### *(ii) Propeller works*

Propeller blade inspections (CPP or fixed types) must also be carried out in the first days. For cracks or other problems, dye penetrant tests must be carried out on the first days. Yard teams must follow proper repair methods if any damages, pitting, or bends are seen during the inspection. Pitting can be repaired with epoxy methods (i.e., Chemcoint, Belzone) or welding with suitable electrodes. For cracks, there can be some welding repairs and cutting processes. For bends with some heat treatment methods, bending can be fixed by heat and pressure.

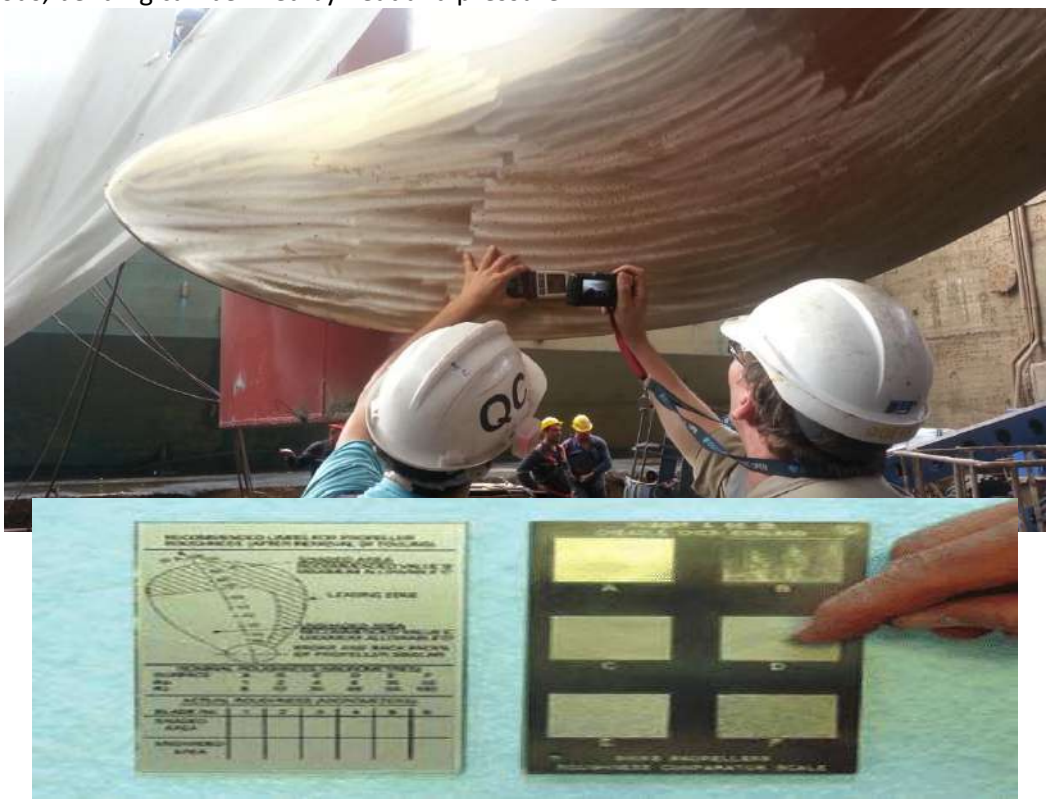



Figure 47 - Propeller Roughness Measurement

Propeller installation is another headache that can block the ship for a couple of months if it fails. Therefore, safe operation with heavy lifters can be one of the best options for expensive parts. As you can see from the video, the total operation takes ~70 minutes without pad eye welding and, of course, without damaging the hull coating.

MPI of the shaft conics also must be checked if needed. Approved companies and people must carry out these non-destructive tests.

Polishing of the propellers can also be carried out during docking or floating conditions. For fuel consumption optimizations, super polishing can be a good option. Repair yards are not so friendly to those applications if you want to check surface roughness (ISO 484) with gauges. A super polish standard is Rupert A, which has 0.65-micron roughness on the surface. Those limits are hard to reach; most yards cannot get that level with standard tools. Experienced teams, proper equipment, and the right inspection tools can give the best results. A dye penetration test of the propeller root and blade can be managed during the first docking days. Shipyards get used to making that test on the last day of the docking after paint application and during the painting process. The above process is a risky application method; if any crack is seen on the edges or root, it can directly delay the undocking operation (second docking, supply of new blade, repair methods, etc.) or vessel departure. Initial days dye penetration tests need to be carried out by yard so that you will have one week in your pocket.

*Figure 48 - Safe Propeller Installation Process - Gemak Shipyard*

*Figure 49 - Propeller Blade Root & Edge Crack Test – Desan Shipyard*

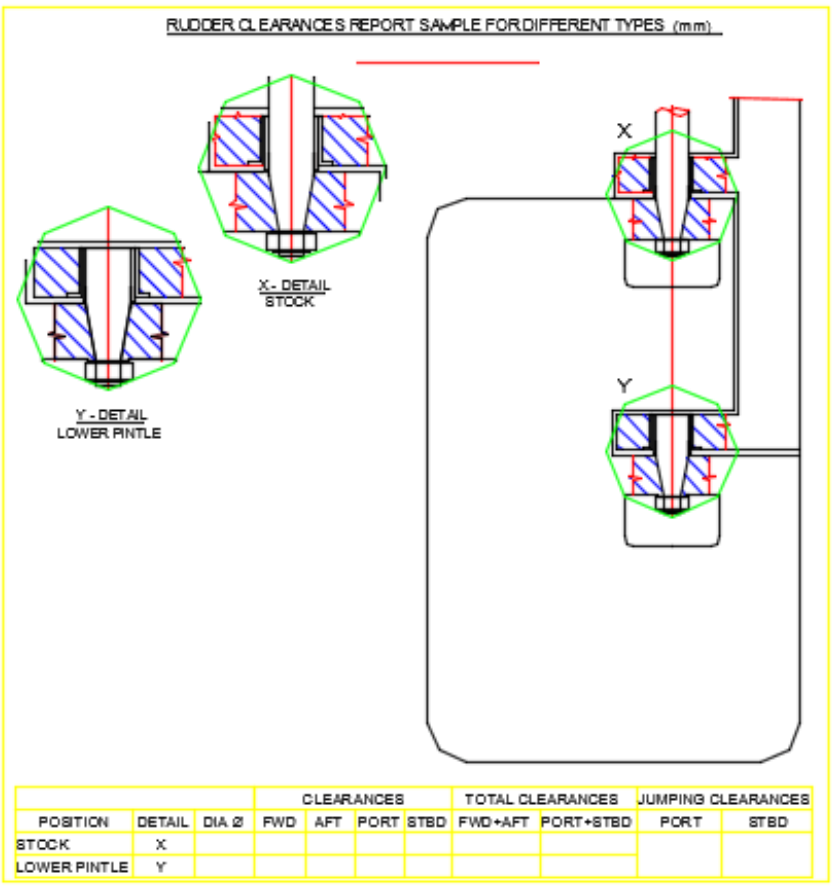
Figure 50 - Damaged Propeller Blade

## (f) Rudder works

**Rudder clearances** must be checked on the initial day of the docking. If oversized dimensions or records had been taken, then renewal of bearing or other options must be limited immediately.

During the bearing renewal, spares and approved methods must be followed by yard teams according to superintendent instructions. Molding epoxies as a bearing chock material for supporting a new bearing is also a different process. During that process, the chock manufacturer's instructions are very strict and must be followed.

Figure 52 - Rudder Pitting




| | | | CLEARANCES | | | | TOTAL CLEARANCES | | JUMPING CLEARANCES | |
|---|---|---|---|---|---|---|---|---|---|---|
| POSITION | DETAIL | DIA Ø | FWD | AFT | PORT | STBD | FWD+AFT | PORT+STBD | PORT | STBD |
| STOCK | X | | | | | | | | | |
| LOWER PINTLE | Y | | | | | | | | | |

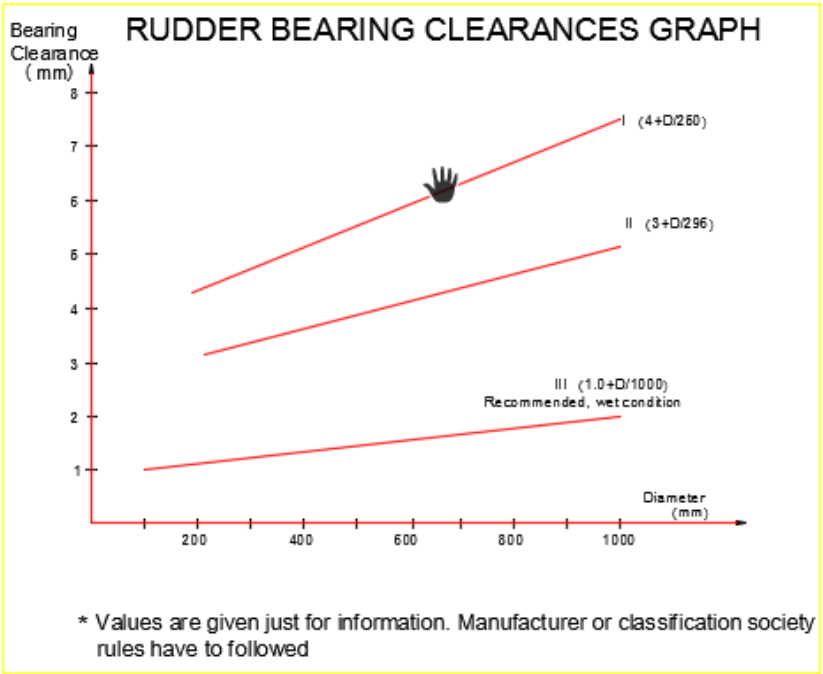



*Figure 51 - Rudder Clearance Report and Graph*

Jumping values are taken just for information. With that measurement, the vessel team or class surveyor can check if there is an alignment problem on the rudder or not. According to cross-checks, in some conditions, the rudder can be removed during the dry dock to give final decisions on bearing and pintle conditions.

Rudder plug openings of the rudder can be carried out with a witness of the class surveyor. If there are water leakages, the yard can carry out suitable types of repairs.

Welding inspections between cast iron and steel parts can check for cracks. If there are cracks or deep pitting on the welding, there can be suitable welding methods for repairs. After repair completion, there can be additional NDT to check the results. Superintendent and yard must be careful about welding quality and procedures between cast iron and steel.

Figure 53 - Rudder Removal and Welding Application

Sometimes, there can be deep corrosion on the rudder's front side because of design problems or cathodic protection systems. In the case of the propeller cone, due to water effects (cavitation, etc.), the thickness of these parts is mostly below the limit. These steel plates must be renewed and coated with special types of epoxies like bow thruster tunnels.

Figure 54 - Stern View & NDT Application on Rudder Welds

After completion of steel renewal works, a pressure test of the rudder blade must be carried out with a witness of the class surveyor. After the pressure test, the bottom plug can close. In some ways, some companies are trying to fill some inert gasses inside of the rudder to protect the corrosion for the inner side, but this protection method is not so often.

### (g) Hull cathodic protection works (Include ICCP, zinc or aluminum anode renewals)

Anodes of the existing system must be cut or removed properly before grit blasting. Existing anode areas need to be marked, or according to the vessel anode plan (drawings), new anode welding works can start after grit blasting works. Welding of the anodes can be completed before the second coat of paint so as not to burn the fresh paint. These welded areas also need to be ground and mechanically prepared for coating. Welded anodes need to be protected with tapes or some fabrics due to overspray of paint. Welded anodes will not work correctly if it is painted.

For ICCP systems, generally, the problem is with the epoxy filler around the ICCP anodes area (Radius 1 – 2 m). That area must be grit blasted to a minimum of SA2 ½ for filler application. Existing filler needs to be removed from the surface because of proper filler application. Repair of filler is not an easy process with standard teams. Most of the yard has no experienced filler application team.

Figure 55 - ICCP Protection

Chemco RS 500P + RA 500M can be applied as a dielectric shield with spray application. During the Chemco system application, surface profile or humidity is unimportant compared to other epoxy systems.

Before painting works, ICCP or sacrificial anodes need to be covered & protected from overspray. Quantities, sizes, and locations of the anodes can be found on vessel new building drawings. If existing drawings or data cannot be in reachable condition, locations or sizes can be measured when the vessel is in a dry dock. If the vessel is also so old, corrosion protection companies can calculate the anode size and quantities as per vessel working condition (seawater salinity, vessel sailing ports, docking period, underwater area, coating system, speed, temperature, etc.).

Figure 56 - ICCP Anode Filler Application (RS 500P + RA 500M with Spray – Dielectric Shield)

### (h) Doppler speed log & Echo sounder & MGPS renewals or repairs,

During the docking preparation, the speed log and echo sounder must be marked on the docking plan and keel blocks preparation; that area must be checked carefully. After completion of docking, these areas must be found to check that they are free from keel blocks and if there is any visual damage!

Figure 57 - Speed Log - Echosounder

Before vessel arrival, these systems' working conditions need to be checked with the vessel team. Suppose a vessel has some problem with the system before the dock entrance. In that case, the owner needs to invite the manufacturer specialist to check the situation to understand whether the problem is software, cabling, or units. During the docking, there can be some ways to control the systems, but these are not approved methods.

If echo sounder or speed log transducer renewal is carried out during the docking works, that area-welding works (NDT, etc.) must be discussed with the class surveyor, and the leak test of the location must be clarified with the yard and surveyor.

Renewal of MGPS anodes can be carried out during the docking period. New anodes can also be fabricated in local workshops, but the best way is to supply from the manufacturer. Mostly, the vessel has no time to provide from the manufacturer or is now insulated, so yard teams must follow the approved heat shrink method to solve the problem.

Figure 58 - Speed Log & Echosounder Position Check – Keel Block Removal

### (i) Ballast tanks coating or steel works,

Some ballast tanks can't be inspected before docking due to vessel ballast conditions, loss of water tightness of bulkheads, mud, etc. After docking operations, the vessel must discharge all ballast tanks first with ballast pumps, then gravity, and finally with bottom plugs. Steelworks can start in the location after freeing the tanks from water and ballast. The critical thing in this location is that profiles or steel parts that touch the bulkheads can create some burned fresh paint on the hull or cargo area. For mechanical preparations and coating areas, work must be carried out immediately before the undocking operation.

Figure 59 - Ballast Tank TU Coating Application with RS 500P – Sefine Shipyard

In addition to that, ballast tanks must be free from water due to condensation, which can affect the hull coating.

Also, with traditional epoxy systems, ballast tank coating works can be carried out in dry dock areas due to reduced humidity. However, some innovative solutions like Chemco Systems that coating works can also be carried out in floating conditions with 100% humidity.

With solvent-free systems, high thickness, humidity, or strong rust cannot affect tank application quality. Even if the existing system was coaltar, Chemco systems could apply on top of that.

### (j) Chain locker cleaning, steel renewals, anchor & chain inspections and chain measurement works,

On the first day of the docking, the yard and vessel team must complete both side chains ranging. For that operation, dockside energy (electrical) for windlass consumptions must be checked. If the yard or vessel thinks there are problems (like proper operation), it can fall down the chain as a bulk with its generators during the floating condition.

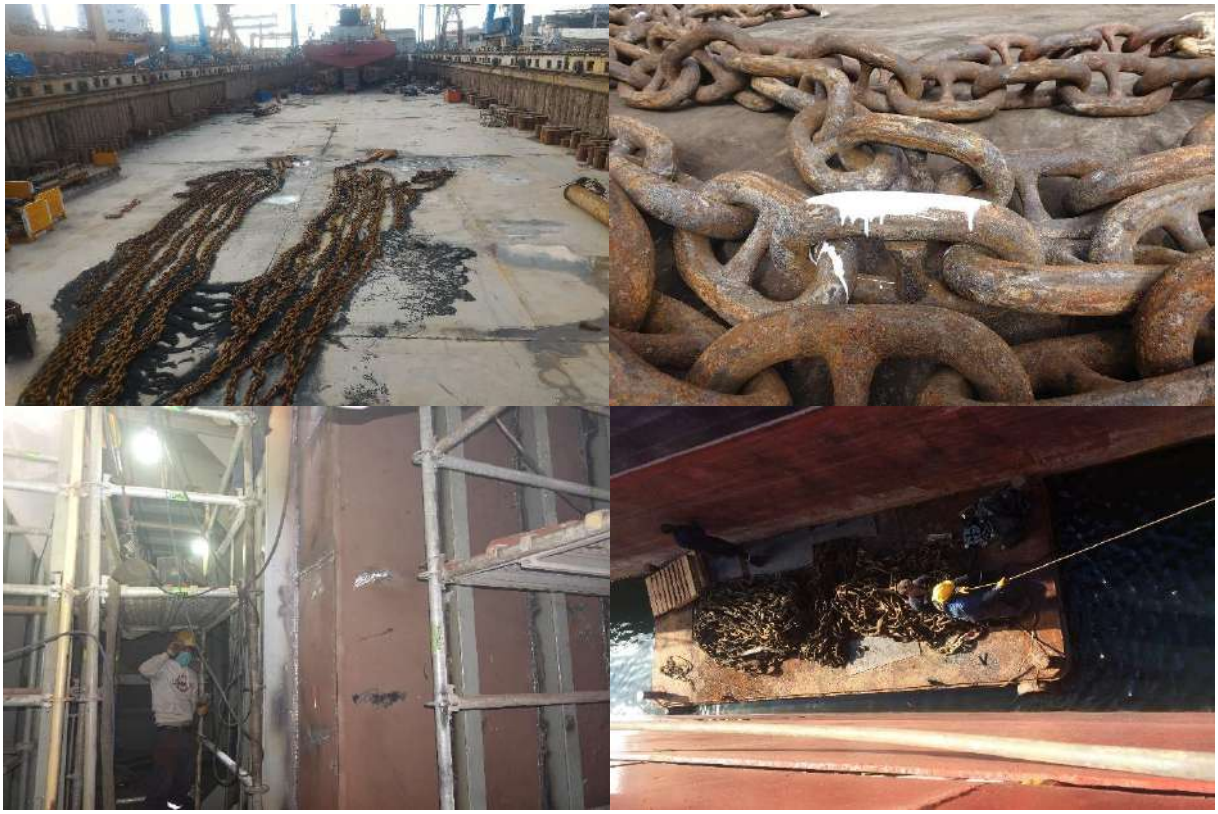


Figure 60 - Chain & Chain Locker Operations

Up to the second day, the yard must be washed entirely (during the hull washing process), the chain must be measured, and the chain reports must be prepared according to class rules. Usually, most class societies wear down the limit to 12%. So, if the thickness is lower than the limits, the chain lengths need to be renewed with an approved supplier.

**SAMPLE CHAIN MEASUREMENT REPORT**

**Vessel Name :** **Date :**

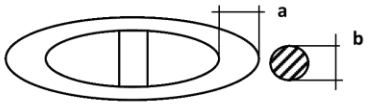
| | PORT | | | | STARBOARD | | | |
|---|---|---|---|---|---|---|---|---|
| | a | b | (a+b)/2 | wear | a | b | (a+b)/2 | wear |
| 1st shackle | 84,40 | 90,50 | 87,45 | 9,8% | 84,10 | 90,00 | 87,05 | 10,3% |
| | 84,20 | 90,30 | 87,25 | 10,1% | 84,00 | 90,20 | 87,10 | 10,2% |
| | 84,00 | 90,10 | 87,05 | 10,3% | 84,20 | 90,10 | 87,15 | 10,2% |
| 2nd shackle | 83,90 | 90,20 | 87,05 | 10,3% | 84,30 | 90,70 | 87,50 | 9,8% |
| | 83,70 | 90,40 | 87,05 | 10,3% | 84,40 | 90,60 | 87,50 | 9,8% |
| | 84,00 | 90,50 | 87,25 | 10,1% | 84,10 | 90,10 | 87,10 | 10,2% |
| 3rd shackle | 83,20 | 90,00 | 86,60 | 10,7% | 84,20 | 90,50 | 87,35 | 9,9% |
| | 83,30 | 89,20 | 86,25 | 11,1% | 84,40 | 90,80 | 87,60 | 9,7% |
| | 83,00 | 89,10 | 86,05 | 11,3% | 84,10 | 90,40 | 87,25 | 10,1% |
| 4th shackle | 83,20 | 88,90 | 86,05 | 11,3% | 84,00 | 90,20 | 87,10 | 10,2% |
| | 83,00 | 88,70 | 85,85 | 11,5% | 84,40 | 90,10 | 87,25 | 10,1% |
| | 83,50 | 89,20 | 86,35 | 11,0% | 84,30 | 90,30 | 87,30 | 10,0% |
| 5th shackle | 82,90 | 89,20 | 86,05 | 11,3% | 83,40 | 89,30 | 86,35 | 11,0% |
| | 83,00 | 89,30 | 86,15 | 11,2% | 83,30 | 89,40 | 86,35 | 11,0% |
| | 83,00 | 89,20 | 86,10 | 11,2% | 83,10 | 89,20 | 86,15 | 11,2% |
| 6th shackle | 87,40 | 89,20 | 88,30 | 9,0% | 83,20 | 89,00 | 86,10 | 11,2% |
| | 86,90 | 89,30 | 88,10 | 9,2% | 83,30 | 89,70 | 86,50 | 10,8% |
| | 87,00 | 89,60 | 88,30 | 9,0% | 83,40 | 89,50 | 86,45 | 10,9% |
| 7th shackle | 85,10 | 87,50 | 86,30 | 11,0% | 82,10 | 88,40 | 85,25 | 12,1% |
| | 85,20 | 87,60 | 86,40 | 10,9% | 82,20 | 88,30 | 85,25 | 12,1% |
| | 84,90 | 87,30 | 86,10 | 11,2% | 82,30 | 88,00 | 85,15 | 12,2% |
| 8th shackle | 96,00 | 100,80 | 98,40 | 0,0% | 82,00 | 88,30 | 85,15 | 12,2% |
| | 96,20 | 100,40 | 98,30 | 0,0% | 82,20 | 88,40 | 85,30 | 12,1% |
| | 96,40 | 100,30 | 98,35 | 0,0% | 82,20 | 88,30 | 85,25 | 12,1% |
| 9th shackle | 86,20 | 87,20 | 86,70 | 10,6% | 85,10 | 88,20 | 86,65 | 10,7% |
| | 86,20 | 87,80 | 87,00 | 10,3% | 85,20 | 88,40 | 86,80 | 10,5% |
| | 86,40 | 87,60 | 87,00 | 10,3% | 84,90 | 88,10 | 86,50 | 10,8% |
| 10th shackle | 83,80 | 88,50 | 86,15 | 11,2% | 82,10 | 88,20 | 85,15 | 12,2% |
| | 83,60 | 88,30 | 85,95 | 11,4% | 82,00 | 88,20 | 85,10 | 12,3% |
| | 83,80 | 88,20 | 86,00 | 11,3% | 82,20 | 88,30 | 85,25 | 12,1% |
| 11th shackle | 83,60 | 88,50 | 86,05 | 11,3% | 81,10 | 88,00 | 84,55 | 12,8% |
| | 83,60 | 88,10 | 85,85 | 11,5% | 81,40 | 88,10 | 84,75 | 12,6% |
| | 83,90 | 88,70 | 86,30 | 11,0% | 81,00 | 88,20 | 84,60 | 12,8% |
| 12th shackle | 82,50 | 88,90 | 85,70 | 11,6% | 81,20 | 88,00 | 84,60 | 12,8% |
| | 82,30 | 88,40 | 85,35 | 12,0% | 81,40 | 88,00 | 84,70 | 12,7% |
| | 82,30 | 88,20 | 85,25 | 12,1% | 81,10 | 88,20 | 84,65 | 12,7% |
| 13th shackle | 82,40 | 88,20 | 85,30 | 12,1% | | | 0,00 | 0,0% |
| | 82,30 | 88,20 | 85,25 | 12,1% | | | 0,00 | 0,0% |
| | 82,70 | 88,60 | 85,65 | 11,7% | | | 0,00 | 0,0% |
| **Average :** | **84,95** | **89,75** | **87,51** | **10,1%** | **83,11** | **89,10** | **86,11** | **10,4%** |
| **Original :** | **97,00** | | | **Max Weardown (%) =** | | **100%** | | |
| **Measurement** |   | | | | | *The grey boxes are the values below minimum diameter | | |
| | | | | | | **Weardown Limit (%):** | | 12% |
| **Measured by:** ..... | **Controlled by:** ..... | | | **Classification Society:** | | | | |

Figure 61 - Chain Measurement Report Sample

Explanation of sample report: According to the information on port side chains 12 and 13 and starboard sides 7, 8, 10, 11, and 12, chain length must be renewed during that docking operation because the measurements are below the limit. In port side 8. shackle is renewed before, so there is no wear down. In addition, the report shows us that for the following survey, both sides will have some shackle renewals, so the ship owner has to arrange some budget for renewals and supplies.

Moreover, loose studs on the chain links need to be inspected with the vessel team (also, if required, with the class surveyor) and marked. Yards need to have an approved welding procedure for loose studs, according to IACS Rec. No: 79. This recommendation shows that before welding, there will be initial heating between 175 °C – 250 °C, welding with low sulfur content electrodes (H5 types) and slowly cooling down (covering with ceramic fabrics or under the dry bulk abrasive) than 48 hours later MPI test for welding. One side of the stud can be welded (opposite side of the common link connection point). D shackle of the anchor and bending of the anchor must inspected.

After ranging the chain, chain locker cleaning and steel works can start simultaneously. Suppose there is a significant amount of steelwork planned in the chain locker. In that case, chain operation can begin after the vessel arrives at the yard area with some floating barge or is lowered directly into the sea.

After cleaning and washing the chain locker, coating work was carried out with the yard team. If there are steelworks in the locker area, the class surveyor can request a leak test, so tests must be carried out before painting.

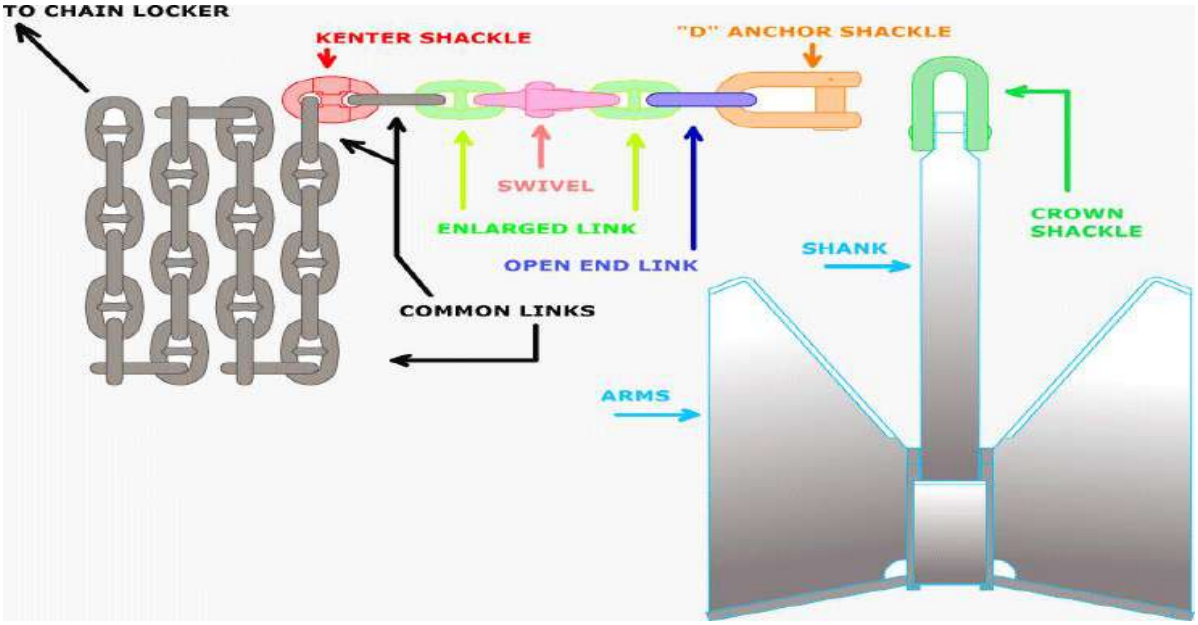



Figure 62 - Chain Parts

Before undocking the chain, the marking must be completed per vessel requirements. The coating of the marking can fail after a few operations, so for that reason, marked links can be clipped with stainless steel materials.

Anchor windlass and other windlass operations (maintenance, brake band renewals, hydraulic pipe works) can be carried out during the docking works.

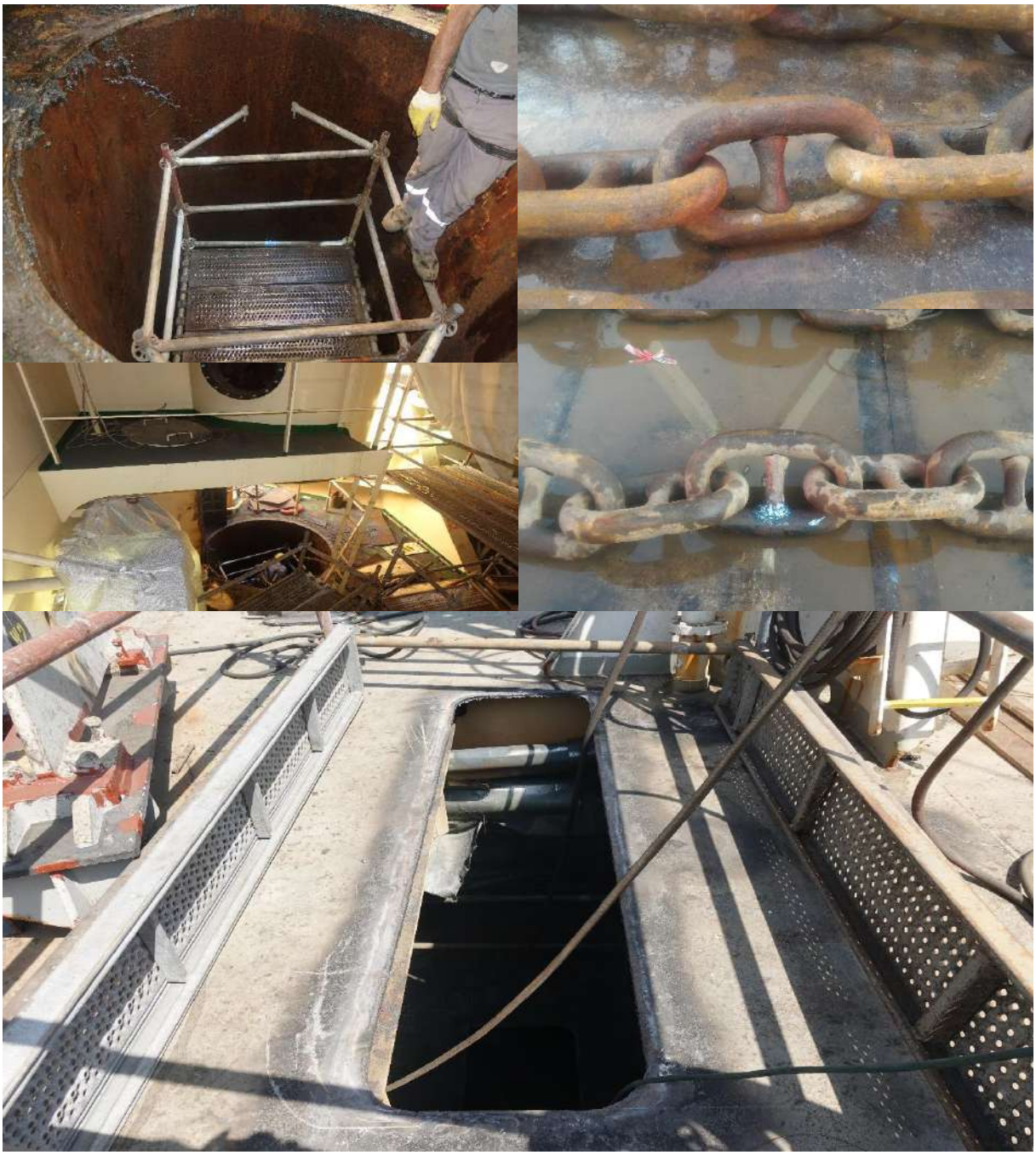


Figure 63 - Chain & Chain Locker Steel Renewal Process

### (k) Ballast pump overhauls,

Ballast pump works can be carried out safely in docking conditions. However, yards and vessel superintendents primarily wish to start that job ASAP because of non-visual problems. Systematical overhauls can start. In any case, a minimum of one of the vessel ballast pumps must be in working condition during docking and undocking operations. Without ballast pumps, operations can also be done with some precautions, which takes time and cost.

Figure 64 - Ballast Pumps in ER

The critical point for a ballast pump overhaul is to manage the overhaul one by one mentality. During the overhaul process, there may be some fabrication or spare requirements, which may delay the vessel. For that reason, always one ballast pump must be in stand-by condition.

### (l) Cooler/heat exchanger cleanings and overhauls,

During the docking period, main engine coolers, LO coolers, or other types can be removed easily. All generators stopped, so it is the best time to do cleaning and maintenance work in the dry dock. However, if there is no overhaul in the engine or other systems, the coolers must fit up on their location for docking or shifting operations.

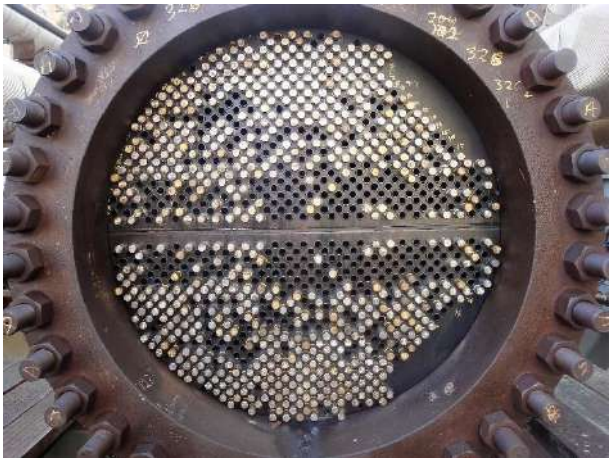


Figure 65 - Cooler Plugging

Coating of cooler covers must be carried out with a proper epoxy system. Corrosion on that side is so much due to temperature differences and erosion factors. Glassflake epoxy systems (RS 500P + RA 500M) can be applied on cooler casings.

Figure 66 - Cooler Case Glassflake Application (Chemco RS 500P + RA 500M Glassflake Epoxy)

Plugging of the tubes has some limitations, and approx. A maximum of 15 – 20% of the tubes can be plugged during the repairs. If plugging started from the last docking or during the sailing, during the planning of the docking, tube renewals must be discussed with the yard before vessel arrival.

### (m) Generator overhauls,

Generator cleaning works, and governor overhauls can be carried out during the docking condition. Usually, step by step, all governors can send to workshops according to the manufacturer maintenance schedule.

For generators, primarily, vessels would like to see a minimum of two generators in working condition during the floating condition. The yard can start the generator overhauls one by one by following that point. But if the vessel is in safe berth condition and all parties agree that minimum generator usage can help vessel operations, in this case, one generator can also solve all vessel problems (with the support of a yard electric connection). During the blackouts, the generator or yard connection can be the solution.

Spares must be ordered before vessel arrival. Generator overhauls can also manage a one-by-one mentality.

Figure 67 - Generator Overhauls

### (n) Windlass overhauls,

Windlasses are accessible for maintenance and repair during the docking period. Brake bands, bearing renewals, or other repairs can be handled without any problem in the dry dock. Also, yard crane availability is helpful during docking conditions.

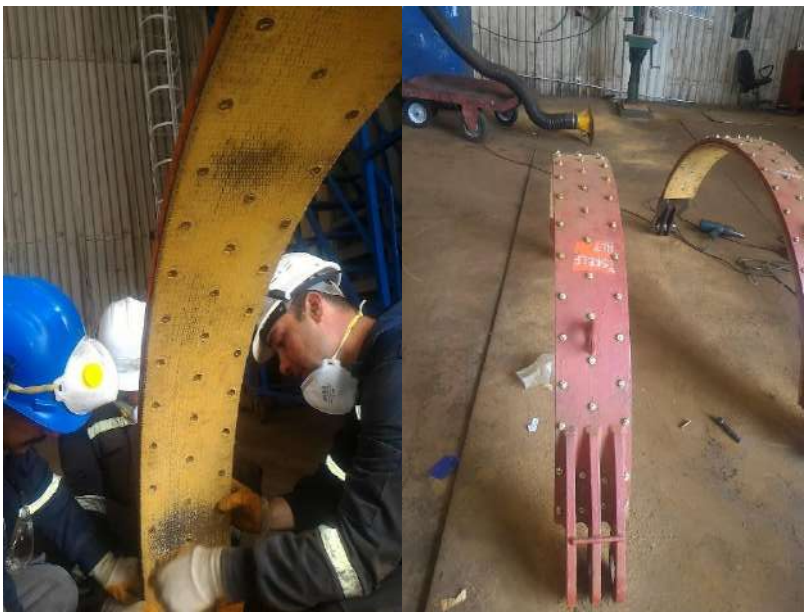


Figure 68 - Brake Band Renewal in Workshop

As standard shifting operations, the berthing condition of the vessel is so important for those overhauls. Usually, the vessel master tries to manage all windlass overhauls during the docking, but this is not the best practice for overhauls because

some broken parts or unexpected problems can delay the undocking and departure of the vessel. All parties must make decisions, and that work is a huge priority. Generators – pipe works related to windlass overhauls must be managed together, so the system must be checked with all items.

- Supplied items must have an asbestos-free certificate.
- Bearings or shafts may need some spray welding/grinding works, so clearances must be checked as per manual or standards,
- The Chainwheel area may need some welding repairs, which must be checked and decided,

Figure 69 - Windlass Repairs – Chocking Compound Application

- If the windlass needs to be removed from the location, the yard team must be warned not to cause any damage to the existing chocking compound (Chockfast, etc.). Still, sometimes it may not be possible, so the alignment of the windlass and the new chocking compound application (Additional 1 – 2 days) must be applied carefully.
- The oily surface around the windlass (which cannot be removed, even with water jetting, etc.) can be coated with oil-tolerant epoxy paint (RL 500PF – Chemco).

Figure 70 - Windlass Overhaul in Workshop

### (o) Some of the deck repairs according to yard crane availabilities etc.

During the berthing position onboard, there can some unreachable areas with cranes to carry out some heavy operations. Those kinds of repairs also can handle in dock area.

Figure 72 - Crane Onsite Machining

Figure 71 - Crane Hydraulic Piston Repairs with Safe Staging

## Section 2.05 Docking & Undocking Operation

### (a) Docking operation

All yards must have a checklist for standard docking operation that must show the minimum below items but not be limited to them.


Figure 73 - Docking Operations

- Arranging ballast condition (Ballast form must be prepared by vessel team with a limitation of yard draft rules), tank selection (Check with steel, coating works, etc.), weight controls with yard design department, etc.
- Arranging of windlass and pumps,
- Lifesaving equipment (Lifeboat – raft, gangways, etc.) must be in working condition if the vessel stays at anchorage for a couple of hours, etc.
- Chain & chain locker condition,
- Ballast tank – hull coating,
- Control of hull for undocking (Shaft – chain, paint searches, etc.)
- The main engine and generators are working condition (governor, etc.)
- Ballast line, overboard valve – pipe checks, etc.
- Shaft – rudder – thruster checks (Oil – leak controls), stern tube oil draining,
- Bottom plug.

### (b) Undocking operation

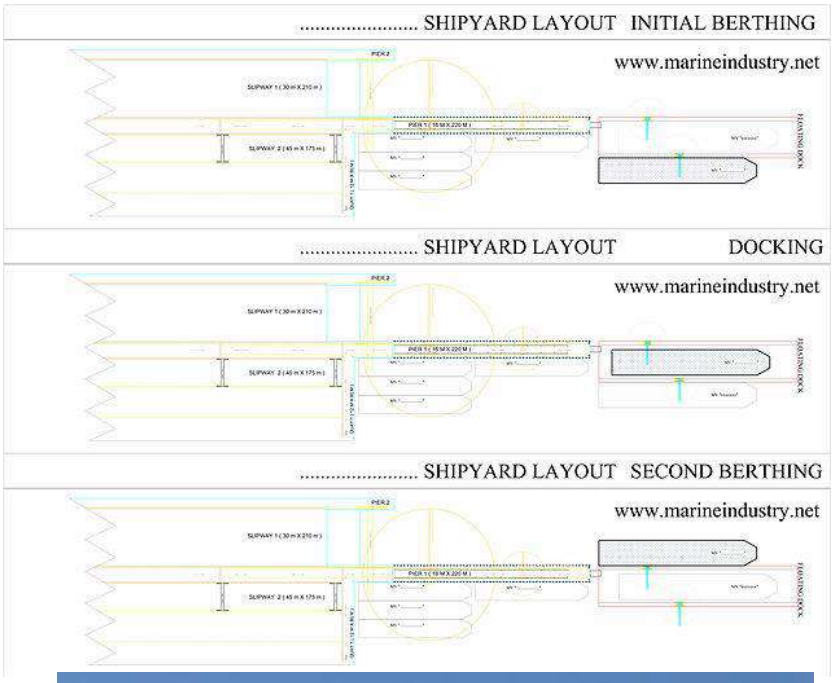
All yards must have a checklist for standard docking operation that must show the minimum below items but not be limited to them.

- Arranging ballast condition, tank selection (Steelworks, coating works, etc.), weight controls, etc.
- Arranging of windlass and pumps,
- Lifesaving equipment (Lifeboat – raft, gangways, etc.) must be in working condition If the vessel will stay a couple of hours at anchorage, etc.
- Chain locker,
- Ballast tank – hull coating,
- Control of hull for undocking (Shaft – chain, paint sea chest, etc.)
- Main engine, generator (governor, etc.)
- Ballast line, overboard valve – pipe checks, etc.
- Shaft – rudder – thruster checks (Oil – leak controls,) stern tube oil filling,
- Bottom plug tests, removal of echo sounder and speed log protection,

Figure 74 - Undocking of Vessel

## Section 2.06 Berthing works

Most vessels are coming to the yard area before docking operations, which we call the Initial Berthing Period. During that period, superintendents can complete final inspections with yard & class surveyors, and marking works can start. The yard team can create outfitting steel works, hold or tank cleaning and coating works, etc. (nearly all works), which are not directly related to the dock. So, the initial berthing period is the first day for repair, which can inform all the parties about the repair schedule, costs, etc.




Some major repairs can also start before the docking operation. These items must be clarified in advance if there are some expected engine, shaft, or other problems. Waiting for spares from the manufacturer can delay the vessels. Trying to save some hundred – thousand dollars $ will not help to save ship owners future contracts or delays.


*Figure 75 - Berthing Works*

# Article III. STEEL WORKS

## Section 3.01 Inspection of Steel Renewals

### (a) Preparation of thickness measurement reports

Based on classification society rules, steel inspections can be carried out with vessel teams and ultrasonic thickness measurements (UTM) teams. The approved inspection can be carried out with the class surveyor and UTM team in the yard area. The thickness measurement report can be prepared as per class requirements. During the inspections, UTM reports can show the corroded areas, and in addition to that report, some bent or deformed areas can change if they are out of limits. However, owners usually wish to reduce the repair period and inspection time as much as possible to avoid losing time. For that reason, during the port inspections or sailing, they invite approved UTM teams together with the class surveyor onboard, and they prepare the UTM Reports as per class requirements.

*Figure 76 - Steel Works Installation*

That table shows one of the well-known class society's permissible thickness reductions according to vessel age. UTM teams are preparing their reports according to the rules and limits (Depends on vessel size, type age etc.).

*Table 7 - Permissible Reduction of Thickness (Sample)*

| Normal and High-Tensile Shipbuilding Steels | Longitudinal Strength | Local Strength | |
|---|---|---|---|
| | | On large surface | Locally |
| Strength deck plating | Max. permissible reduction of midship section modules: 10 % (3) | For t ≤11.5 mm 1.5 mm<br>For t >11.5 mm 0.09t+0.45 mm (max. 3 mm)<br>(t= plate and/or web thickness as stipulated in Construction Rules, mm) | 20 % |
| Continuous longitudinal hatch coamings | | | 20 % |
| Deck plating within inside line of hatchs | | | 25 % * |
| Forecastle and poop deck plating | | | 25 % * |
| Tween deck plating | | | 25 % * |
| Side sheel plating | | | 20 % |
| Sheer strake plates | | | 20 % |
| Bilge strake plates | | | 20 % |
| Bottom plating | | | 20 % |
| Keel plate | | | 20 % |
| Inner bottom plating | | | 20 % |
| Longitudinal bulkheads | | | 20 % |
| Wing tank and hopper tank sloped plating | | | 20 % |
| Transverse bulkheads, transverses, bulkhead web stiffeners and stringers, brackets and hatch side girders (1) | | | 25 % * |
| Longitudinal frames, girders | | | 20 % |
| Plates in way of tank top | | | 20 % |
| Underdeck box girders (longitudinal and transversal) | | | 20 % |
| Hatch covers (2), hatch coamings and brackets | | | 25 % * |
| Bridge deck plating, superstructure end bulkheads | | | 25 % * |

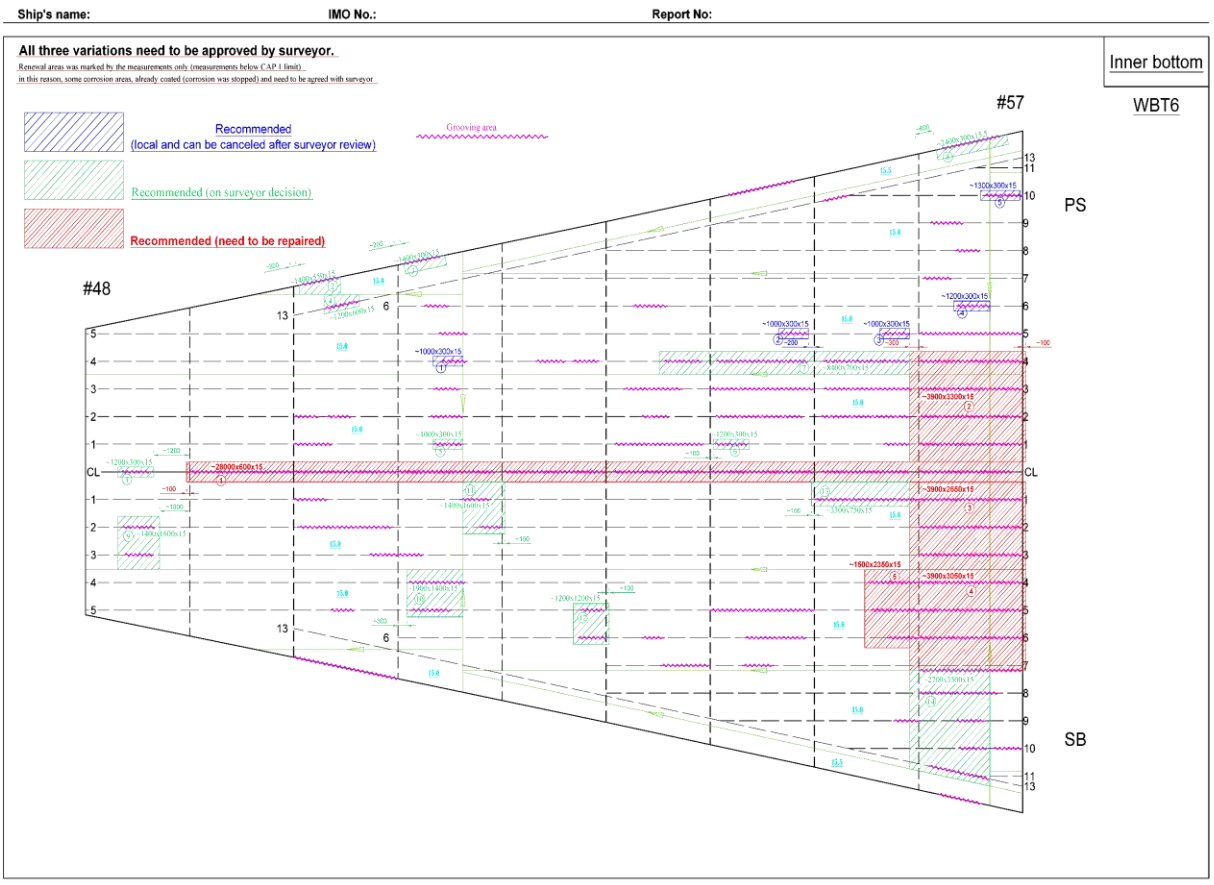



*Figure 77 - Marking of Steel Works as per UTM Reports*

During the yard inspections, the class surveyor can make some cross-checks with a report to ensure that the measurements of the reports are accurate. With some additional thickness measurement requests, they can complete the survey. The owner must also record existing reports of the vessel so surveyors can check the existing condition of the steel.

For some reports, there can be some areas that can change or not. Additional measurements can taken, and according to the owner's request, the vessel can change its status (CAP1 – CAP2, etc.) so that permissible reductions can be changed.

## Section 3.02 Condition Assessment Program (CAP)

The CAP (Condition Assessment Program) survey generally applies to tanker vessels close to or older than 15 years (during the 3. Special Survey) and to container carriers and other types of vessels at 20 – 25 years old. With CAP 1 – 2 rating conditions, vessels can find better cargo but, of course, with an expensive maintenance cost if routine repairs aren't managed up to CAP year. Major oil companies mostly ask for a minimum CAP 2 rating for tankers.

CAP 1 means even if your vessel is 15 years old, the condition of construction, and the systems are in new building levels. CAP surveys generally focus on CAP-Hull (structural components, coating conditions, etc.) and CAP Machinery/Cargo System. [1]

UT teams need to start CAP survey inspections for vessels a minimum of 3-6 months before the vessel yard period. UT measurements can show the initial budgets to the shipowner, and in addition to that, the shipowner and yard teams can plan the vessel's initial repair. Time-consuming activities of CAP surveys are steel renewals in ballast & cargo tanks and tank coating activities, so an inspection can start with class surveyors before vessel arrival to the yard (~3 months before) and can be completed ASAP in the yard area for unreachable locations.

*Table 8 - CAP Survey Limits Example for Steel Thickness Measurements*

| CAP Rating: | Allowable General Corrosion: |
|---|---|
| CAP 1 – Very Good condition | Less than 1/3 of the allowable margin wasted |
| CAP 2 – Good condition | Between 1/3 and 2/3 of the allowable margin wasted |
| CAP 3 – Satisfactory condition | Between 2/3 and 3/3 of the allowable margin wasted |
| CAP 4 – Poor condition | Below the allowable margin |

After that inspection, the UT team can prepare the thickness measurement reports, and the coating condition can be identified with the coating inspector or class surveyor. After receiving those two reports, the shipowner representative can check the locations and condition of the vessel, and they will have a chance to review the vessel condition improvement rating (CAP 1 or CAP 2) target together with chartering departments and yard schedules, etc. or even shipowner can decide to sell the vessel.

Again, machinery and cargo systems are easy to improve if compared with ballast & cargo tank conditions.

*Table 9 - Steel Thickness Diminution Limits for CAP Survey*

| *Category of Structural Member* | Maximum Diminution | | | |
|---|---|---|---|---|
| | LEVEL 1 | LEVEL 2 | LEVEL 3 | LEVEL 4 |
| **Category-A (Plate:)**<br>- Shell plates<br>- Strength deck plates<br>- Slab longl. on sheer strake and stringer plate of strength deck<br>- Tight bulkheads in deep tanks<br>- Inner bottom plates | 8 % | 16 % | 25 % | - |
| **Category-B (Primary members)**<br>- Floors and girders<br>- Web frames (web and face plates) | 8 % | 16 % | 25 % | - |
| **Category-C (Secondary members)**<br>- Frames with brackets (web and face)<br>- Longitudinals (web and face)<br>- Stiffeners | 10 % | 20 % | 30 % | - |

During the inspection, locations can be marked for steel works, but for coating repairs, the useful sketch can help all parties during the planning, budgeting, or clarification of the work scope.

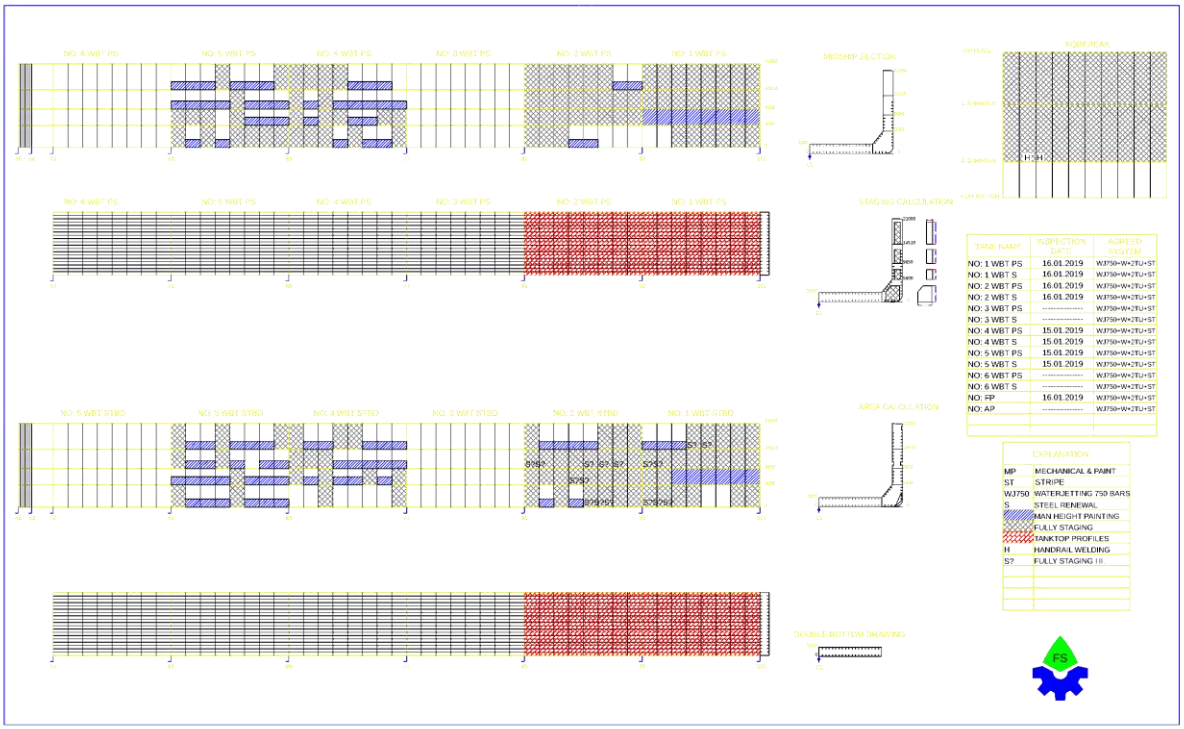


*Figure 78 - Ballast Tank Condition Inspection Sketch for Staging & Coating*

One of the best guidelines for ballast tank inspections is IACS Rec. 87. (IACS Recommendation 87 Guidelines for Coating Maintenance & Repairs for Ballast Tanks and Combined Cargo/Ballast Tanks On Oil Tankers). In that recommendation, you will have a chance to understand photo comparison of surfaces as per ratings.

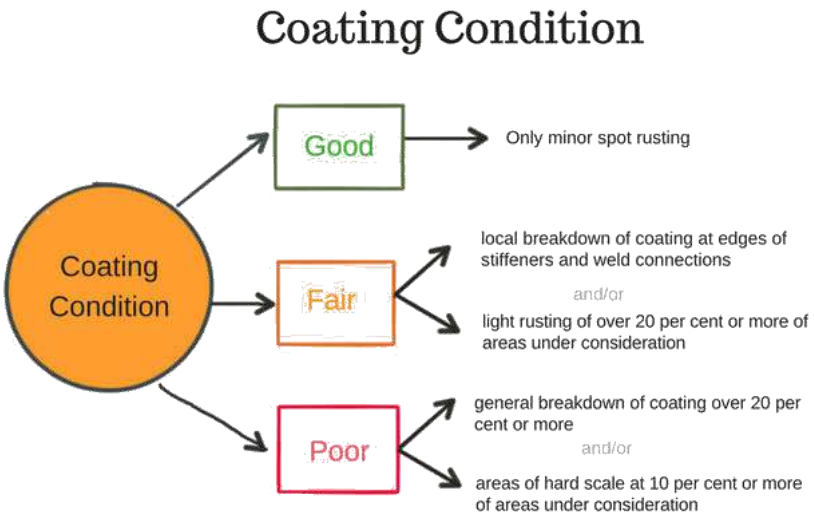



*Figure 79 - Coating Condition Levels as Per IACS*

*Figure 80 - Ballast Tank Condition (Poor)*

*Figure 81 - Ballast Tank Condition (Good)*

During the ballast tank inspection, critical areas are;

- Fore & Aft Bulkheads & Cargo Side Bulkheads (Watertight Bulkheads),
- Block erection joints,
- Bellmouth areas (Under the bellmouth, etc.),
- Steel renewals, etc.

These locations must be in "Good" condition or need to be painted as per regulations. The class surveyor will confirm the vessel's condition with evidence photos for their head offices.

*Figure 82 - CAP 1 Final Inspection for Critical Locations in Ballast Tanks*

*Figure 84 - Cargo Condition for CAP Survey*

Deck condition is also critical for the CAP survey. All deck equipment and coating conditions must be " Good ".

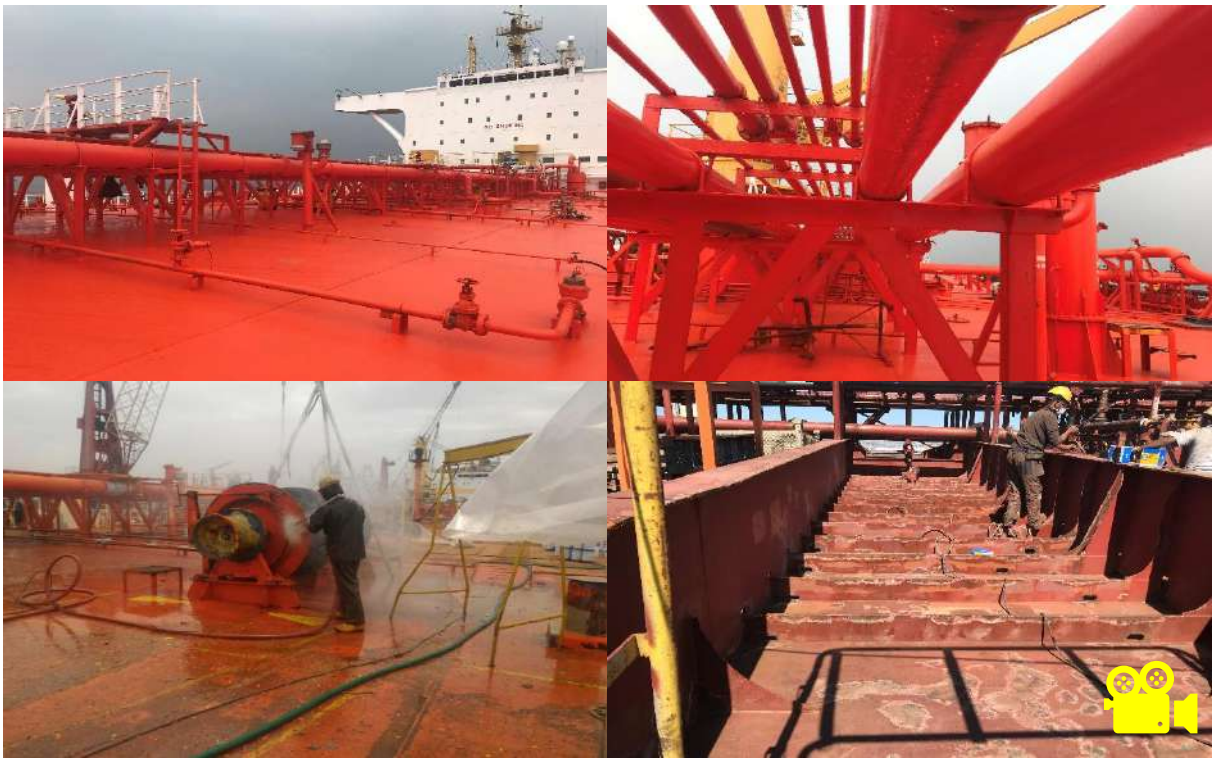


*Figure 83 - Deck Coating Condition for CAP Survey*

### (a) Marking of steel renewals

Marking of the steel, which is below the limit, and deformed areas can be inspected with the surveyor, vessel team, and yard team together according to class rules. IACS REC 47 – Ship Building and Repair Quality Standard is the best solution for all parties. According to the standard minimum, marking dimensions must be known by the yard team.

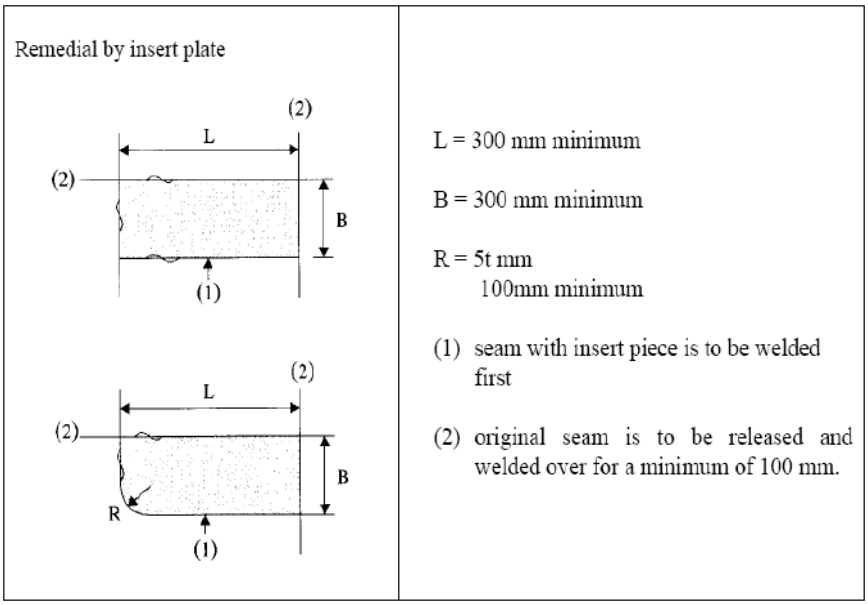



*Figure 85 - Marking of the Steel Parts as Per IACS Rec. 47*

If there are existing welding seams, marking and renewal of the part must be 90 ° to the new seem. The continued part must pass the other side if the problem on the longitudinal or bulkhead penetration pieces.

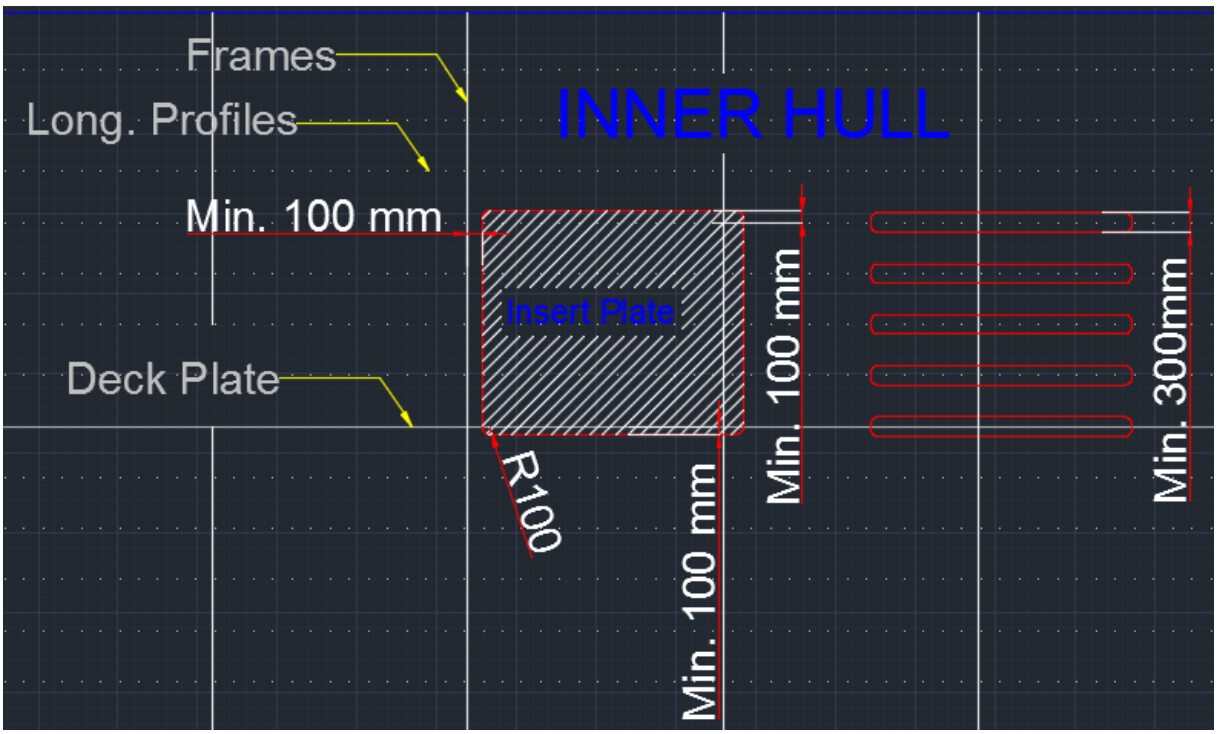



*Figure 86 - Marking Suggestions for Steel Works*

There can be several ways of marking. In the above AUTOCAD drawings, there are two different types of marking on the same corrosion–stress problem. The problem is in the way of the longitudinal profiles on shell plates. Per IACS rules, the ship-owner can repair just with a 300 mm beam insert plate (right side – 5 pcs.) or one part as a rectangular (left side – 1 pc.). Both are acceptable by class and yard, but as an engineer, a one-part insert is better than 5 pcs insert. If you check heat input, UTM and welding length, minimum kg/pcs. for yard calculations, risk of welding problems, etc., one part can be

more reasonable for the yard, owner, and most probably by the class surveyor. To reduce the scope of work, a bigger part of that marking can reduce budget and time together.

After completion of proper marking, the yard team must arrange for some design teams to prepare initial drawings for owner confirmation ASAP (6 - 24 hours). After confirming drawings, yard teams can start the work, and the owner can calculate the weights and check with the class surveyor if there are some misunderstandings or future, yard teams can start the work, and the owner can calculate the weights and check with the class surveyor if there are some misunderstandings or future problems.

*Figure 87 - Marking of Steel Plates Before Cropping*

## Section 3.03 Steel Renewals According to IACS Rules – Drawings

Steel renewal works are the most common for all yards and must be carried out according to IACS rules. IACS rules show us the proper way to make approved steel renewal works for new buildings. In addition to IACS rules, class society rules are also very important. So, during the repair yards, owners must follow class surveyor suggestions. Yards must submit the approved procedures to the owner and class society (with permission of the ship owner) in advance (WPS – WPQR – Welder Certificates, Pipe or Steel Plate Certificates, etc.).

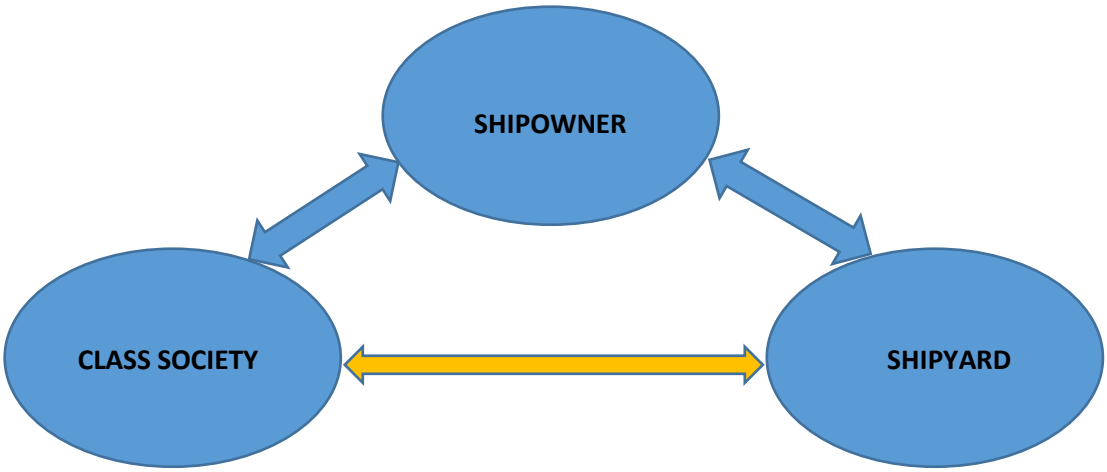



*Figure 88 - Relationships with Parties*

The proper ways of communication between Ship-owner – Class Society – and Shipyards are given above with a blue double arrow. Usually, the class society cannot order any renewals or maintenance from the yard team, and the yard cannot discuss any matter directly with the class society without permission from the owner. For this reason, ship-owners must manage both sides according to rules, budgets, etc. However, the yard, owner, and class society practically decide to add an orange double arrow to reduce time and communicate better. Alternatively, sometimes ship-owners arrange for more professional steel supervisors and coating inspectors for major projects to follow up the above communication system.

During the steel renewal, important items are.

- Approved procedures and welders from the yard (WPS – WPQR – Welder Certificates),
- Approved steel plate and consumables (If possible, have to be class approval certificate from vessel class; if not by another IACS member society but for different class approved products, vessel class surveyor can request additional analysis and tests),
- Experienced teams from the yard and proper plan for modification, quality team, and proper equipment.
- Cropping and welding plans to avoid deformations or keel problems.
- Minimum heat transfers to steel plate during the cropping, fit up, or welding.
- Analysis of availability of steel parts from local or global market on time (±1 mm or different grade of steel that is also given same strength, hardness, etc. or better).
- Approved testing methods after renewals.

**6.2 Renewal of plates**

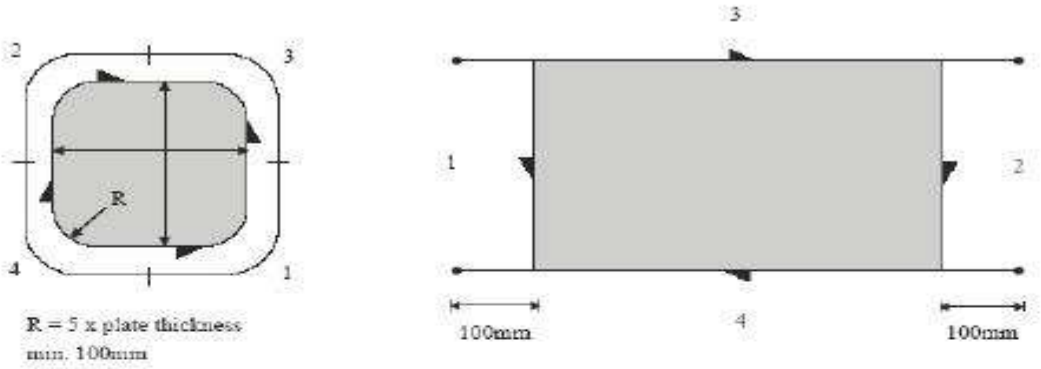



**Fig 6.2 Welding sequence for inserts**

| Item | Standard | Limit | Remarks |
|---|---|---|---|
| Size Insert | Min. 300 x 300 mm<br>R = 5 x thickness<br>Circular inserts:<br>$D_{min}$ = 200 mm | Min. 200 x 200 mm<br>Min R = 100 mm | |
| Marterial Grade | Same as original or higher | | See Section 4. |
| Edge Preparation | As for new construction | | In case of non compliance increase the amount of NDE |
| Welding Sequence | See Fig 6.2<br>Weld sequence is<br>1→2→3→4 | | For primary members sequence 1 and 2 transverse to the main stress direction |
| Alignment | As for new construction | | |
| Weld Finish | IACS Recommendation 20 (ref. 10) | | |
| NDE | IACS Recommendation 20 (ref. 10) | | |

*Figure 89 - Steel Renewal Rules as per IACS Rec. 47*

All steel works must be carried out with some procedures. Before starting renewal, yards must prepare steel renewal drawings for owner (or class) confirmations. This confirmation can save the ship owner and yard for later discussions. In addition to that, initial drawings can help to solve problems with class surveyor comments.


*Figure 90 - Steel Works Examples on Hull & Deck*

Usually, yard teams are experienced in steel works, so the yard has no chance of failing IACS Standards or general procedures. So, in some situations, before drawing preparations, yard teams can start the renewal of steel parts immediately as per marking. In any case, the yard must prepare design drawings for the owner to take confirmations from the class society immediately and for budget calculations.

Class surveyors have no duty to check that the drawings match their comments. Surveyors can share their comments about steel renewals and review their comments as per Class / IACS rules. At the beginning, during the contract period, yards are confirming that they will follow IACS rules for their repair activities.

*Figure 91 - Steel Renewal on Hull & Cargo Bulkheads*

### (a) Cold Cutting

Cold cutting (mobile 1000 bars or above) is a safe way for steel works, which can reduce work scope and costs so much. It is a slow but efficient way for fuel oil – cargo tanks, etc...

*Figure 92 - Cold Cutting with Waterjets (Exproof) on Hull*

*Table 10 - Ballast Tank Steel Renewal Plan Sample*

| Example Of Steel Renewals in Ballast Tanks | Duration | Resource Names |
|---|---|---|
| **No:1 PS Tank (~8.500 kg)** | **12 days** | |
| Marking of the corroded areas with class surveyor and yard team according to UTM report | 8 hrs. | Project Eng., Class Surveyor, Superintendent |
| Transportation of cutting and welding equipment's onboard and completion of connections, preparations of design drawings | 48 hrs. | Worker [10], Designer [2] |
| Cropping of marked areas as per confirmed yard drawings | 96 hrs. | Fitter Team [3] |
| Cutting of new plates in CNC and transferring to vessel | 72 hrs. | CNC [3] (5%) |
| Transferring of new parts to the ballast tank area with a proper access from main deck area | 120 hrs. | Worker [8] |
| Fitting of new parts on the areas | 120 hrs. | Fitter Team [6] |
| Welding of new parts as per welding plan | 144 hrs. | Welder [12] |
| NDT and leak test of the tank with sea or fresh water | 6 hrs. | Project Eng., Welder [3] |

*Figure 93 - Steel Inserts in Ballast Tanks*

According to the plan and duration, some work can be conducted simultaneously so that the plan can be checked from the website for details. After completion of steel renewals, these parts must be painted with a sound system. With an approved ballast tank coating method, products like RS 500P & RA 500M can apply rusty and wet surfaces (no dehumidification, grit blasting, etc.) on new or existing metal after washing and cleaning. These systems can save time, money, and undesirable delays and protect the areas in the long term.

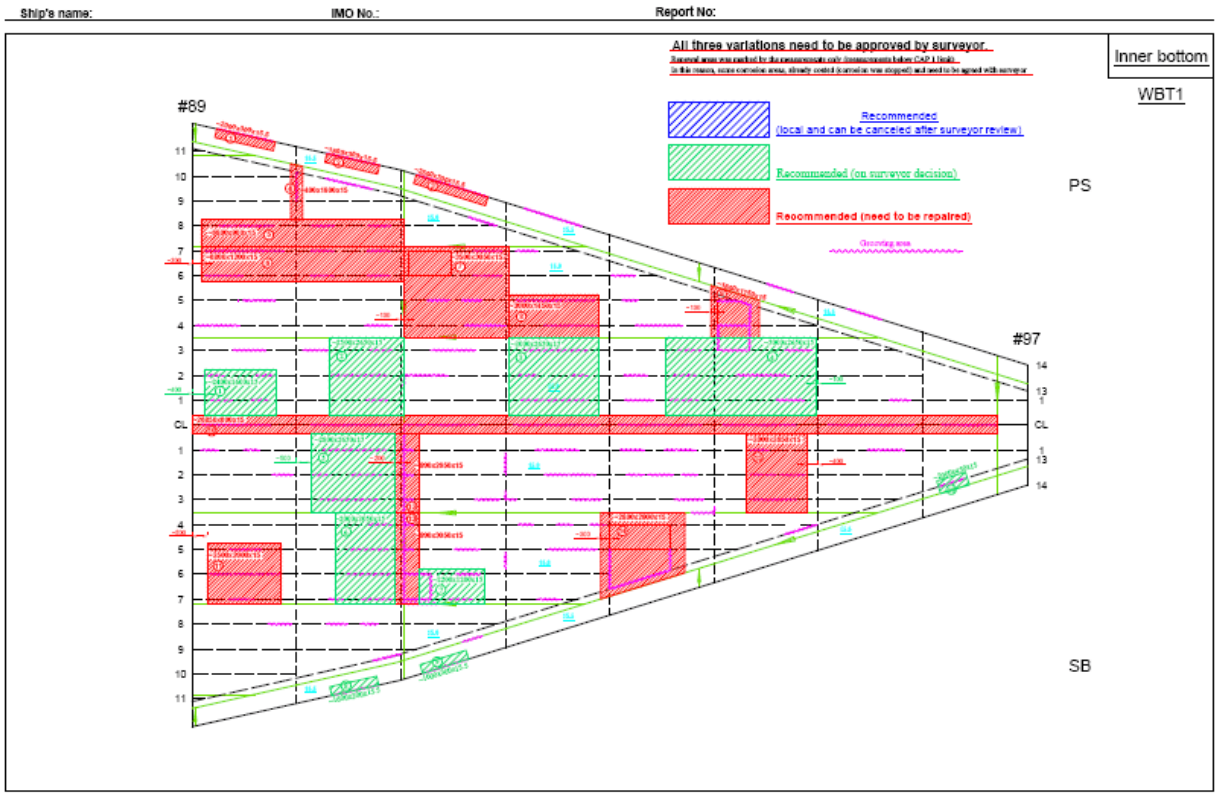



*Figure 95 - Deck UTM Report and Steel Renewal Sketch*

For welding calculations (gas metal arc welding method – horizontal position) with a 100% efficiency (which is impossible), one welder can weld approx. 300 mm/minute for 1 seem. But it's 100 – 120mm/minute when the welders start for work. Welders' efficiency can be calculated at 30-35% in most cases with an optimistic calculation.

| **Steel grades according to Classification Societies' rules (ref. 5)** | | | | | | | **Comparable steel grades** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Grade** | **Yield stress $R_{eH}$ min. N/mm²** | **Tensile strength $R_m$ N/mm²** | **Elongation $A_5$ min. %** | **Average impact energy Temp. °C** | **J, min. L** | **T** | **ISO 630-80 4950/2/3/ 1981** | **EN EN 10025-93 EN 10113-93** | **ASTM A 131** | **JIS G 3106** |
| A | 235 | 400-502 | 22 | +20 | - | - | Fe 360B | S235JRG2 | A | SM41B |
| B | | | | 0 | 27 | 20 | Fe 360C | S235J0 | B | SM41B |
| D | | | | -20 | 27 | 20 | Fe 360D | S235J2G3 | D | (SM41C) |
| E | | | | -40 | 27 | 20 | - | S275NL/ML | E | - |
| A 27 | 265 | 400-530 | 22 | 0 | | | Fe 430C | S275J0G3 | - | - |
| D 27 | | | | -20 | 27 | 20 | Fe 430D | S275N/M | - | - |
| E 27 | | | | -40 | | | - | S275NL/ML | - | - |
| A 32 | 315 | 440-590 | 22 | 0 | | | - | - | AH32 | SM50B |
| D 32 | | | | -20 | 31 | 22 | - | - | DH32 | (SM50C) |
| E 32 | | | | -40 | | | - | - | EH32 | - |
| A 36 | 355 | 490-620 | 21 | 0 | | | Fe 510C | S355N/M | AH36 | SM53B |
| D 36 | | | | -20 | 34 | 24 | Fe 510D | S355N/M | DH36 | (SM53C) |
| E 36 | | | | -40 | | | E355E | S355NL/ML | EH36 | - |
| A 40 | 390 | 510-650 | 20 | 0 | | | E390CC | S420N/M | AH40 | (SM58) |
| D 40 | | | | -20 | 41 | 27 | E390DD | S420N/M | DH40 | - |
| E 40 | | | | -40 | | | E390E | S420NL/ML | EH40 | - |

Note: In selecting comparitable steels from this table, attention should be given to the requirements of Table 4.1 and the dimension requirements of the product with respect to Classification Sociey rules.

*Figure 94 - Steel Grades Reference According to IACS*

Therefore, the yard team and superintendent must carefully calculate some special welding on the hull (or cargo tanks, fuel oil tanks, etc.), which affects the undocking or departure of the vessels. During the welding calculations, both parties can cross-check those calculations to see if these are true, or if additional precautions are needed, these can be discussed.

## Section 3.04 Inspection of Steel Renewals,

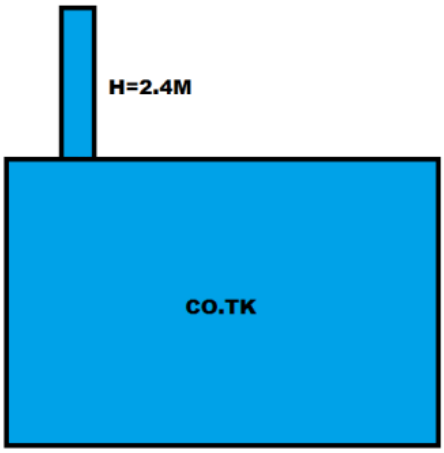
Generally, class surveyors inspect all steel renewals. According to IACS rules, constructional and strengthening parts can be examined with “Visual Inspection” and with non-destructive testing “NDT” methods.

*Figure 96 - Delivery of Steel Works & NDT Preparations*

During the “Visual Inspection” method, the welding seam can be checked, and renewed parts can be checked by size.

NDT inspections can be managed in different ways. Generally, leak tests can be carried out with vacuum tests and pressure tests with air or water (Hydrostatic Test) in closed areas.

During the pressure test with water, a U-tube system can used. Another and easiest way is to manage overflow. The height of the water level can be 2.40 meters above the top point of the tank for overflow.




After filling the tank and U – Tube, remove (not closing the valve) the water connection to check the stable pressure,

- Wait around one hour,
- Check the water level and filling of the tank for blinds, etc.
- Check the welding seems all around the tank (new ones),
- After inspection completion, remove the water from the tank, check all blinds and valves, etc., one by one, and clean and free the lines.

For air tests, the standard test pressure is 0.15 bar for tanks. Tank must pressurize up to 0.20 bar ~1 hour, then can reduce 0.15 bar. During the inspection, all welding seams must be washed with soapy water. Leaks can be controlled easily, if any.

The vacuum box method is another solution for inspections. The vacuum box method allows small areas and corners to be checked quickly. But in this test, you can't reach such high pressures like hydrostatic tests.

*Figure 97 - Hydrostatic Test of Cargo Tanks*

With NDT methods, ultrasonic tests (UT) or dye penetrant tests are the most known methods for ship repair. The UT system can inspect all welding seams by class-approved (certified) NDT inspectors.

Testing with air and NDT methods is easy to proceed with. But for extensive repairs, hydrostatic tests (For cargo or ballast tanks) will be safer to check and see all problematic areas – if they have any. Especially for fuel oil tanks, air tests, and NDT combinations will be very useful. With the hydrostatic tests, ship owners also have a problem of the disposal of oily water. So, the superintendent or yard engineers must make proper project management together with class surveyors.

*Figure 98 - Vacuum Test and NDT Tests*

## Section 3.05 Different Steel Type Renewal Methods

Sometimes, there can be some damage to the hulls, holds, or tanks during vessel operations. That kind of damage can be repaired with some temporary or permanent solutions.

### (a) Doubler repair

Those repairs are temporary systems that protect the construction's vessel strength or water tightness. The general mentality of those types of repairs is to acceptably solve the steel condition (corrosion, cracks, etc.) problems.

"Local doublers are normally only allowed as temporary repairs, except as original compensation for openings, within the main hull structure."

Doubler plate welding procedures are the same as insert plate renewals as per IACS Regulations.

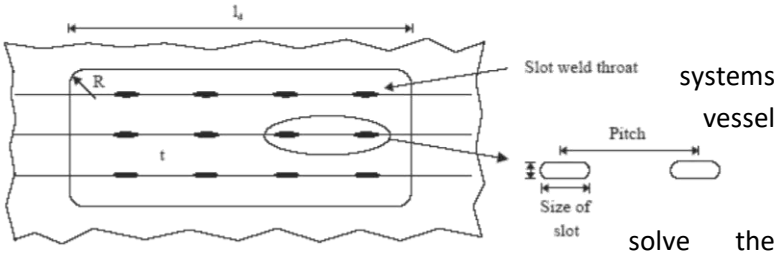



**Fig 6.3 Doublers on plates**

| Item | Standard | Limit | Remarks |
|---|---|---|---|
| Existing Plating | | General: t ≥ 5 mm | For areas where existing plating is less than 5 mm plating a permanent repair by insert is to be carried out. |
| Extent / Size | Rounded off corners. | min 300 x 300 mm<br>R ≥ 50 mm | |
| Thickness of Doubler (td) | td ≤ tp<br>(tp = original thickness of existing plating) | td > tp/3 | |
| Material Grade | Same as original plate | | See Section 4 |
| Edge Preparation | As for [newbuidling] new construction | | Doublers welded on primary strength members: (Le: leg length)<br>when t > Le + 5 mm, the edge to be tapered (1:4) |
| Welding | As for [newbuidling] new construction | | Welding sequence similar to insert plates. |
| Weld Size (throat thicknesss) | Circumferencial and in slots: 0.6 x td | | |
| Slot Welding | Normal size of slot: (80-100) x 2 td<br><br>Distance from doubler edge and between slots:<br>d ≤ 15 td | Max pitch between slots 200 mm<br><br>dmax = 500 mm | For doubler extended over several supporting elements, see Figure 6.3 |
| NDE | IACS Recommendation 20 (ref. 10) | | |

*Figure 99 - Doubler Repairs as per IACS Rules*

### (b) Epoxy repairs,

Epoxy repairs are mainly to solve pitting and other types of corrosion problems. These systems can reduce or especially stop the corrosion on the surfaces. With some locations, vessels can solve their pitting problems without additional repair. The thickness of the steel must be more than allowable limits. With glass flake epoxy systems, that kind of repair can be a permanent system that can save the vessel steel structure up to scrap.

In accommodation decks (B deck, C deck, Wings, in front of accommodation on main deck, funnel decks, etc.), fuel oil tank top plates that kind of system can used. Those systems can solve the corrosion problems and save so much time for tank cleanings, insulation renewals, etc., in the way of steel renewals. Chemco International RS 500P + RA 500M systems can solve those problems with water jetting and painting.

*Figure 100 - Epoxy Repairs on Pittings (Offshore or Accommodation Decks)*

### (c) Crack or hole repairs

Crack repairs are one of the most complex challenges for steel renewal operations. Generally, yards follow the standard steel renewal procedures for those repairs, but steps must be followed as below.

1. Cleaning of the surface with proper methods,
2. Crack test for clarification of crack (direction and endpoints),
3. Drilling of the crack endpoints with a rotary drill,
4. Cropping of the steel as per IACS rules,
5. Welding of new parts,
6. Vacuum & NDT checks of welding seams and crack test of the location.

*Figure 101 - Special Hole / Crack Repair Practices*

If the steel cropping starts before the cracks are drilled, the cracks will continue in non-damaged areas. As you can see from the pictures above, the cracked area has already failed without proper preparation. And yard teams began to follow appropriate repair methods after their failure.

### (d) Sandwich systems

These systems strengthen modified systems, which can help the vessel's special locations. On the hull, mainly, they can be used in the way of fuel-oil tanks or tug points.

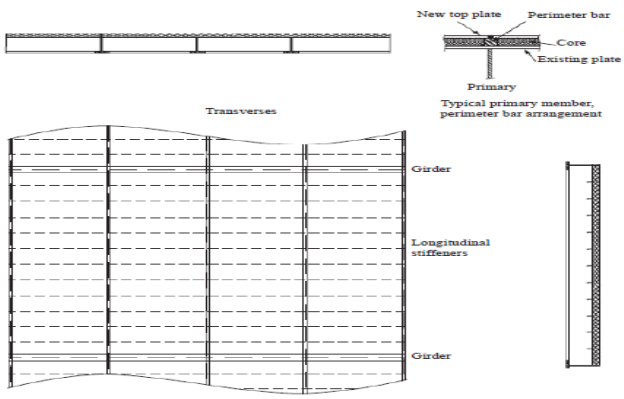



*Figure 102 - Sandwich Systems for Steel Strengthening*

## Section 3.06 Calculation of Steel Weights According to Rules

Repair specifications are preparing ship-owner representatives before vessel arrivals to the yard. For that reason, nearly all the yards are giving their quotations with unit prices and some extra charges according to the quantity of the works, locations, parts sizes, steel grades, etc. Changing the steel parts inside the double bottom is typically more complex than on the main deck, and curved plates are hard to manufacture and weld.

The items below will show the general practice of steel renewals in shipyards. Of course, some shipyards give the quotation with some extra or lump sum price mentality.

*Table 11 - Steel Works Pricing Rule Explanations in Shipyards*

| Yard Rules | Add. Factor | Explanation |
|---|---|---|
| Steel Grade (Standard: A Grade) | 10 – 20% | Steel grade can change according to vessel structure and design. Therefore, with different grades, there can be a 10 – 20% difference in the unit price. Stainless steel or/Al materials can be more different. |
| Shape factor | 5 – 20% | Due to CNC cutting (loss of parts and scrap pieces), the yard can add extra cost. If the parts are rectangular or 95% is rec. It is a normal part. For brackets, part with holes… |
| Minimum weight (i.e. 50 kg.) | - | For small pieces, shipyards will calculate the minimum weight. According to project details, it can be reduced for each piece. |
| Location factor | 10 – 40% | Tanks, engine room, bulbous, void spaces (confined) locations are hard to work, so yard will have additional fees for those locations. |
| Bending Factor | 10 – 30% | Bending is a different process for steelworks - bulbous parts, shell plates, etc. Double bending for the same plate will charge double the additional factor. |
| Thickness of the plate (t<10 mm or 25<t) | 10 – 25% | Low thicknesses and high thicknesses need different welding processes and proficiencies. |
| Less quantities in one location – Mobilization costs (Total steel quantity < 300 – 750 kg) | …. USD | Yards will have mobilization costs for ventilation, welding equipment transfers, etc. With larger quantities, i.e.,>750 kg, the unit price can cover that cost. |
| Access Plates | 60 – 90% | The renewals or tank entrances, yard may need some openings from existing plates. The yard can be charged as a steel renewal price (60 – 90 % of the unit price). |
| Welding seem renewal (I.e. min. 5 Meter) | …. USD/m | The unit price for welding repairs can be different from steel renewal. Cutting of existing welding can also be calculated as a run. |
| NDT Tests | Service<br>Meter | Service prices and meter prices can be charged separately. For small sizes, just a service price can be charged. |

Those extras can be charged as an additional sum. I.e., if the part is hull plate in bilge keel location (bent) and it is inside the ballast tank (Bending factor: 10% Location Factor: 20%) price of the bracket will be 130% (100% + 10% + 20%) of unit price (not 100% x 110% x 120% = 132%) for fairness.

## Section 3.07 Outfitting works

Outfitting renewal works can be carried out as per existing vessel constructions. For that reason, yards are managing the outfitting works after inspections. However, if some parts are fabricated, or modifications are needed, yards must make new parts per some standards (JIS F, NORSK, etc.). Sometimes, yards may have standards that must be designed in detail and submitted to the owner for future modifications and repairs.

### (a) Mushroom repairs:

Mushroom repairs can be carried out mainly after removing mushroom heads due to safety procedures. After inspections, some steel renewals can be carried out with coating renewals. In addition, stainless steel mesh renewals may be required during the inspection process. After completion of the works, the yard can blast and paint the steel constructions for long-term protection.

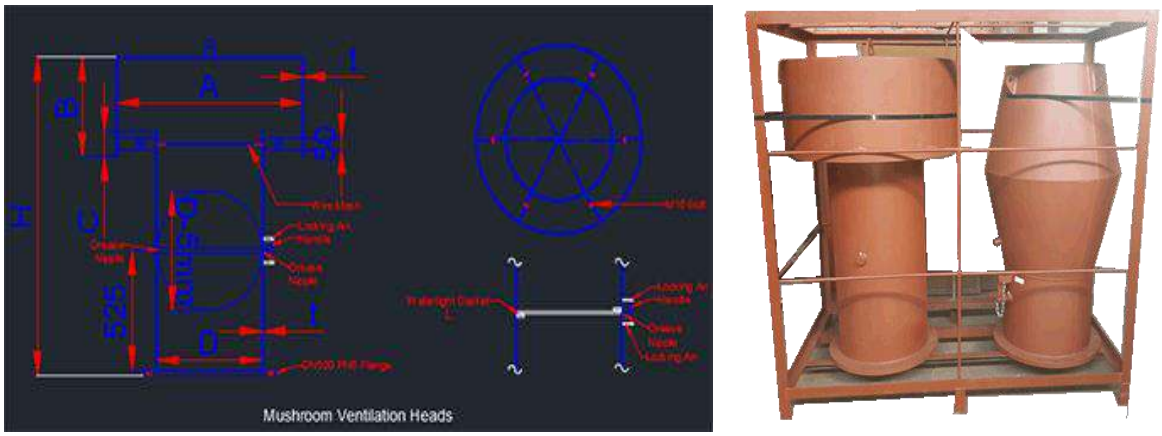



*Figure 103 - Mushroom Ventilation Systems*

### (b) Accommodation ladders (Aluminum repairs), pilot ladders,

Pilot ladders are the units in which pilot or class surveyors can see the vessel's condition. If we believe "First Impression" is so important, cleaning and general condition of the ladders must be perfect. There are many types and sizes of accommodation ladders, but each type has the same problems. Aluminum welding systems are essential for that kind of repair.

After completion of the work, aluminum and galvanized parts can be painted with RL 500PF (Compatible with galvanized surfaces) epoxy system.

*Figure 104 - Accommodation Ladder Load Test*

### (c) Ventilation heads,

Ventilation head corrosion protection is a major problem for vessels. Those parts need to be painted with proper products and systems. (Chemco RS 500P Epoxy)

Covers can be fabricated with mesh, and a crew can carry out standard maintenance.


*Figure 105 - Ventilation Head Corrosion Protection*

### (d) Bollards,

Generally, repair on bollards can done by yard as an outfitting works (welding or corroded part renewal. Sometimes, there can be some modifications to the bollard system due to rope operations (New Panama Channel Regulations, etc.).

The ship-owner team must prepare initial drawings in advance with class approval, or the yard team must help the owner with engineering services.

Bollards were also ordered before the vessels arrived at the yard area. After fabrication of those parts, fabricated bollards must be tested (Pull off, hardness, etc.) with a witness of the class surveyor, or if it is ready, the class surveyor needs approval after confirmation of welding proper NDT can manage. Safe working load marking (SWL) must be shown on bollards with permanent systems (welding, etc.).

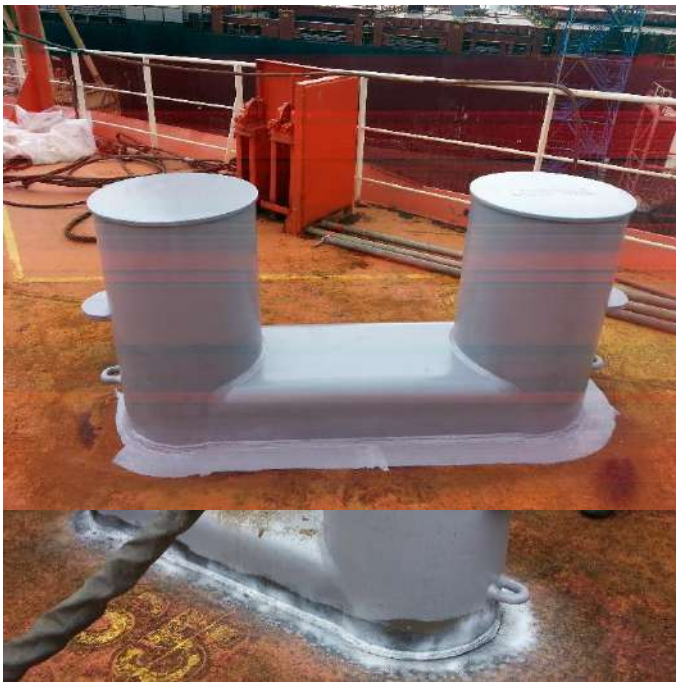


*Figure 106 - Bollard Installations with NDT*

### (e) Chocks,

Generally, chock repairs are known as welding repairs on the inner side of it (i.e., rope passageway) or renewal of the chock with its foundation. The same procedures are valid for chocks; again, permanent SWL marking must be done after completion with welding. FAZER 63 XHD type repair electrodes can be used for those high-abrased areas.

That kind of modification is one of the critical paths for ship repair projects. These are related to tanks, class inspections, coating works, etc., so all details must be on the project plan.

Also, welding repairs of chocks, windlass, etc., must be prepared with approved electrodes and procedures.

*Figure 107 - Chock Repairs*

Especially for mold products, H5 electrode usages are a must.

### (f) Foundations

Foundations are mainly outfitting parts for ship equipment. The foundations are constructed primarily by profiles and thin (3 – 6 mm) steel plates for small-sized equipment. For windlass, main engines, etc., the thickness can be 10 – 50 mm. depending on the size of the equipment and strength requirements.

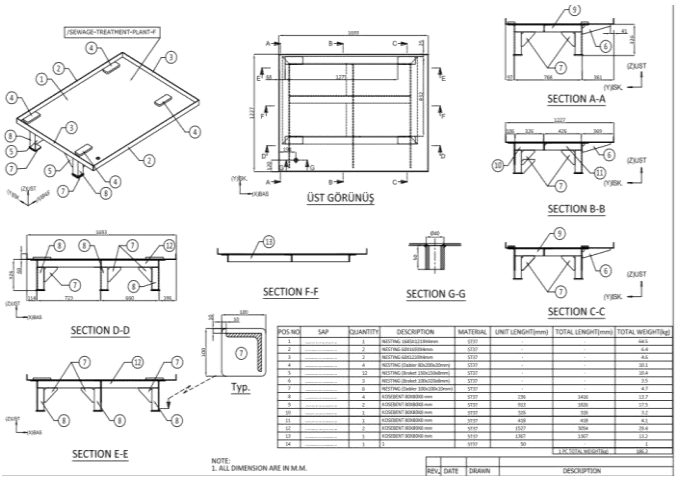



*Figure 108 - Foundation Fabrication Drawing*

All equipment must fit on the foundation to save the ship hull or deck plate. In addition, foundations can protect the equipment against vibration effects, corrosion, etc. Fabrication can be managed during the yard period, and generally, there will be no delay in fabrication.

We suggest welding support brackets under the foundation between the deck or shell plates. These additional brackets can save the area from corrosion and stress effects.

*Figure 109 - BWTS Equipment and Pipe Foundations - Supports*

*Figure 110 - Panel and Chemical Tank Foundations*

### (g) Cable trays – cabling works

Cable tray installations are related to outfitting works. Parts must be galvanized during the fabrication process. After welding steel parts to the tray, welding damages must be ground and painted with epoxy paints (RL 500PF – Compatible with galvanized coatings). Also, the trays' size, the cable ties' connection, vibration points, and bulkhead penetrations are critical for cable laying.

*Figure 111 - Cable Trays*

Especially for cable penetrations, the size of the pipe–bulkhead penetration pieces is essential. All class societies have rules with the same mentality. Details of the rules can be found on the technical data sheet for filling the compound as per their approval.

### (h) Davits – lifeboats – accommodation ladders

Davits and lifeboats are critical for crew life at sea and port state controls. During the shifting operations, those systems must be in working condition. Due to the crucial duty of systems, lifeboat maintenance can be done simultaneously during the docking period or safe berthing (without shifting) period. The vessel may need some operations; if life-saving systems are not working, the master will have a right to reject any shifting operations or wait in the anchorage area.

Figure 112 - Lifeboats & Davits Maintenance - Tests

## Section 3.08 Special Type Steel Works

### (a) Hatch cover steel renewals

Hatch cover steel renewals are sensitive works during the yard period. Heat transfers during the cropping of the steel parts or deformations can cause headaches to the shipowner & shipyard if they have no proper plan for testing and renewals.

The main hatch cover steel renewal tricks are checking leak points with hose tests before transportation or starting any heat transfer. That hose test can save shipowner and shipyard rights.

All leak locations must be marked on the sketch during the test and fixed during the repair process.

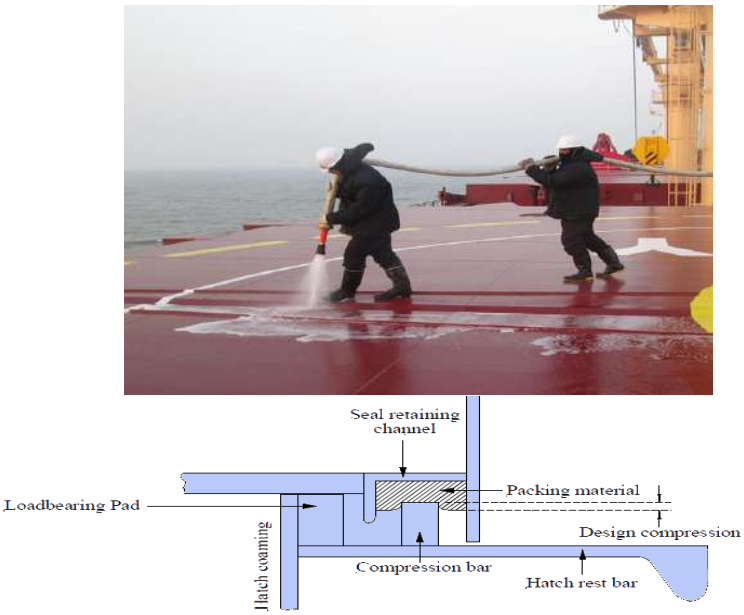



*Figure 113 - Leak (Hose) Test of Hatch Covers*

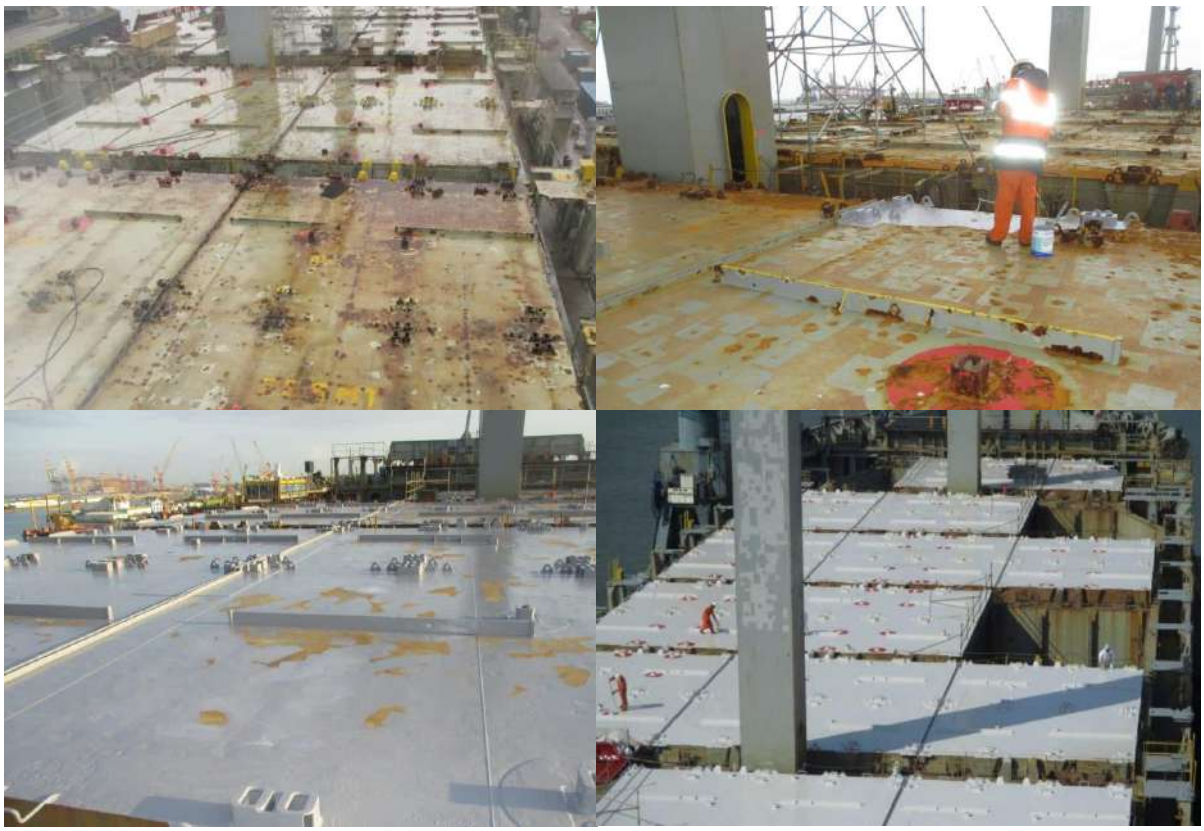


*Figure 114 - Waterjetting (500 - 800 bars) and 2 Coat Glassflake Epoxy Application (RA 500M)*

The best way to solve pitting and corrosion problems on hatch covers is to use unique epoxy systems like Chemco RS 500P + RA 500P Glassflake epoxies.

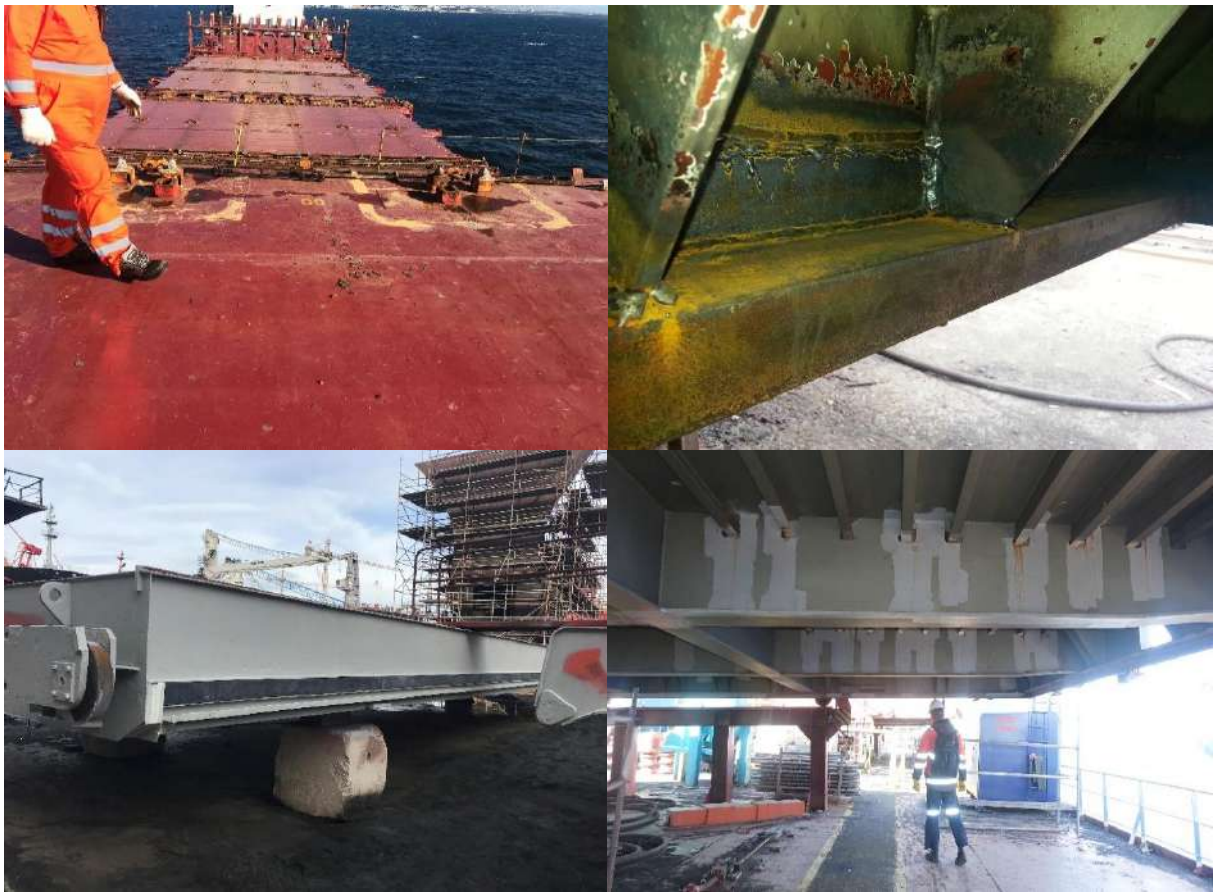


*Figure 115 - Hatch Cover Steel & Coating Works*

If there are any steel repairs on hatch covers, the shipyard must prepare the yard hatch cover arrangement plan for repairs. The cover resting plan and work scope must be checked before confirmation of the offer. If there is any possible repair, the owner must inform the yard in advance.

Staging arrangements are also taking time during the installation and removal period. So, this item will be a critical measurement, and decisions must be made immediately for quick action.

After installation of the staging works, dimensional calculations must be recorded by the vessel and yard team for budget calculations and locations.


*Figure 116 - Waterjet Selection for Deck & Tank Coating Works (2000 bars - 8 liters)*

### (b) Cell guide renewals

Cell guides are critical parts of container vessels that must be corrected with the proper procedures and welding systems. For small-sized, partly repaired, alignment must be checked visually by yard and vessel teams. But for extensive-sized repairs. During the fit-up and after the welding process, all renewed cell guides must be measured with approved systems. The easy way is to check the alignment with the ready containers or same-size steel constructions.

In addition, tests, cell guide quality control plans, and measurements must be prepared by the yard for significant projects. It depends on vessel construction, of course, but normally 150x150x15 mm. L profiles can used as a standard guide construction. Before any docking period, the ship owner must inform the yard about the size and quantity of cell guides to check availability from the market.

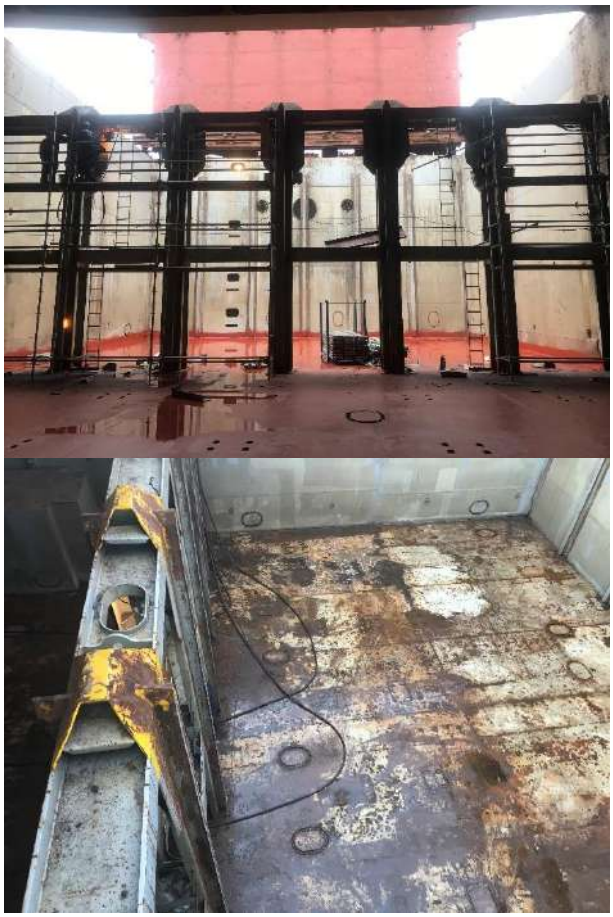


*Figure 117 - Cell Guide Renewal Works*

## Section 3.09 Stainless Steel Production Process at Shipyards

The welding process of stainless-steel products are rare application in shipbuilding & repair projects but nowadays, together with new regulations, it will be more common and major works at shipyards. During the scrubber projects, there are some welding processes for SS materials (or SMO 254 nickel alloys, etc.) that can be a big headache for shipyards and owners. Repairs for chemical tankers are also another field for SS productions and repairs. Two major points can be critical for that kind of material;

1. Welding Procedure Qualification Record (WPQR)
2. Passivation of welding seams and surfaces. (Grinding + Chemical Process)

WPQR can be managed by yards in the area and can be checked by the vessel team and class surveyors in advance (before vessel arrival). Different types of steel need to be certified for also welders.

*Figure 118 - Stainless Steel Tank Grinding & Passivation - Istech*

# Article IV. PIPE WORKS

Pipe renewal works can be carried out according to class rules and for some additional precautions if required. The critical side of the repair must be carried out as per IACS rules and with proper materials.

Pipes must be seamless and according to standard thickness and size. Generally, onboard SCH40 (Schedule 40) or SCH80 pipes are used according to requirements. SCH160 pipes must be used with class certification Type 3.1 or Type 3.2 for overboard pipes according to class requirements. However, finding the exact SCH160 pipes during the repair period takes work. For that reason, the minimum thickness of the pipes overboard must be checked by the yard superintendent–class surveyor to find optimum pipe dimensions to proceed with the repair works to be completed on time.

After the fabrication of pipes, corrosion protection is one of the most important things for the extent of the system's life cycle.

Working with a coating expert will be very helpful for companies during the fabrication and installation of new lines, parts, etc. Case by case, they can check the structure's location, environment, and forces and decide the most optimistic solution together with superintendents.

*Figure 119 - Pipe Fabrication in Workshop with Coating (RS 500P + RA 500M – Glassflake Epoxy)*

*Table 12 - Pipe Wall Thickness as per IACS Rules*

**Minimum wall thickness for steel pipes (All dimensions in mm)**

| Nominal size | Outside diameter | Wall thickness | | | |
|---|---|---|---|---|---|
| | | A | B | C | D |
| 6 | 10,2 | 1,6 | | | |
| | 12 | 1,6 | | | |
| 8 | 13,5 | 1,8 | | | |
| 10 | 17,2 | 1,8 | | | |
| | 19,3 | 1,8 | | | |
| | 20 | 2 | | | |
| 15 | 21,3 | 2 | | 3,2 | |
| | 25 | 2 | | 3,2 | |
| 20 | 26,9 | 2 | | 3,2 | |
| 25 | 33,7 | 2 | | 3,2 | |
| | 38 | 2 | 4,5 | 3,6 | 6,3 |
| 32 | 42,4 | 2 | 4,5 | 3,6 | 6,3 |
| | 44,5 | 2 | 4,5 | 3,6 | 6,3 |
| 40 | 48,3 | 2,3 | 4,5 | 3,6 | 6,3 |
| | 51 | 2,3 | 4,5 | 4 | 6,3 |
| 50 | 60,3 | 2,3 | 4,5 | 4 | 6,3 |
| | 63,5 | 2,3 | 4,5 | 4 | 6,3 |
| | 70 | 2,6 | 4,5 | 4 | 6,3 |
| 65 | 76,1 | 2,6 | 4,5 | 4,5 | 6,3 |
| | 82,5 | 2,6 | 4,5 | 4,5 | 6,3 |
| 80 | 88,9 | 2,9 | 4,5 | 4,5 | 7,1 |
| 90 | 101,6 | 2,9 | 4,5 | 4,5 | 7,1 |
| | 108 | 2,9 | 4,5 | 4,5 | 7,1 |
| 100 | 114,3 | 3,2 | 4,5 | 4,5 | 8 |
| | 127 | 3,2 | 4,5 | 4,5 | 8 |
| | 133 | 3,6 | 4,5 | 4,5 | 8 |
| 125 | 139,7 | 3,6 | 4,5 | 4,5 | 8 |
| | 152,4 | 4 | 4,5 | 4,5 | 8,8 |
| 150 | 168,3 | 4 | 4,5 | 4,5 | 8,8 |
| | 177,8 | 4,5 | 5 | 5 | 8,8 |
| 175 | 193,7 | 4,5 | 5,4 | 5,4 | 8,8 |
| 200 | 219,1 | 4,5 | 5,9 | 5,9 | 8,8 |
| 225 | 244,5 | 5 | 6,3 | 6,3 | 8,8 |
| 250 | 273 | 5 | 6,3 | 6,3 | 8,8 |
| | 298,5 | 5,6 | 6,3 | 6,3 | 8,8 |
| 300 | 323,9 | 5,6 | 6,3 | 6,3 | 8,8 |
| 350 | 355,6 | 5,6 | 6,3 | 6,3 | 8,8 |
| | 368 | 5,6 | 6,3 | 6,3 | 8,8 |
| 400 | 406,4 | 6,3 | 6,3 | 6,3 | 8,8 |
| 450 | 457,2 | 6,3 | 6,3 | 6,3 | 8,8 |

Notes of Table are given below and noted from requirements concerning “PIPES AND PRESSURE VESSELS” from IACS documents.

Columns **A, B, C,** and **D** in the table apply to the following services:

- **A.** Pipes, in general
- **B.** Vent, overflow, and sounding pipes for integral tanks
- **C.** Bilge, ballast, and seawater pipes
- **D.** Bilge, ballast, vent, overflow, and sounding pipes pass through the fuel tank: Bilge, vent, overflow, sounding, and fuel pipes pass through ballast tanks.

Notes:

1. The nominal sizes, pipe diameters, and wall thicknesses given in the table are many common sizes based on international standards. Notwithstanding the requirements of Table 3, diameter and thickness according to other national or international standards may be accepted.
2. Where pipes and any integral pipe joints are protected against corrosion by means of coating, lining, etc., at the discretion of the Classification Society, the thickness may be reduced by not more than 1 mm.
3. For sounding pipes, except those for flammable cargoes, the minimum wall thickness in column B is intended to apply only to the part outside the tank.
4. The minimum thicknesses listed in this table are the nominal wall thickness. No allowance is needed for negative tolerance or a reduction in thickness due to bending.
5. For threaded pipes, where allowed, the minimum wall thickness is to be measured at the bottom of the thread.
6. The minimum wall thickness for bilge lines and ballast lines through deep tanks will be subject to special consideration by the Classification Society. The minimum wall thickness for ballast lines through oil cargo tanks is not to be less than that specified by UR F15.
7. The minimum wall thickness for pipes larger than 450mm nominal size is to be in accordance with a national or international standard and, in any case, not less than the minimum wall thickness of the appropriate column indicated for 450 mm pipe size.

With the above limits, all pipes must be checked and confirmed with drawings. Yards are always following SCH40 – SCH80 pipes to make it simple. Optimization and standardization of supplies are also very important.

According to location and line, Std. (Standard) SCH40, SCH XS (Extra Heavy), or SCH80 can be used. So generally, for big diameters (above DN400), sure vessels can use SCH40 instead of SCH80 without galvanizing. But again, those kinds of decisions need to be discussed with class society.

*Table 13 - Pipe Dimensions as per Standards*

| NOMINAL PIPE SIZE INCHES | | Outer Dia. Ø mm | Standard mm | kg/m | Sch40 mm | kg/m | Sch60 mm | kg/m | Extra Strong (XS) mm | kg/m | Sch80 mm | kg/m | Sch120 mm | kg/m | Sch160 mm | kg/m |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inch | DN | | | | | | | | | | | | | | | |
| 1/4" | | 13,7 | 2,2 | 0,63 | 2,2 | 0,63 | | | 3 | 0,8 | 3 | 0,8 | | | | |
| 3/8" | | 17,1 | 2,3 | 0,85 | 2,3 | 0,85 | | | 3,2 | 1,1 | 3,2 | 1,1 | | | | |
| 1/2" | 15 | 21,3 | 2,8 | 1,26 | 2,8 | 1,26 | | | 3,7 | 1,62 | 3,7 | 1,62 | | | 4,8 | 1,95 |
| 3/4" | 20 | 26,7 | 2,9 | 1,68 | 2,9 | 1,68 | | | 3,9 | 2,19 | 3,9 | 2,19 | | | 5,6 | 2,89 |
| 1" | 25 | 33,4 | 3,4 | 2,5 | 3,4 | 2,5 | | | 4,5 | 3,23 | 4,5 | 3,23 | | | 6,4 | 4,23 |
| 11/4" | 32 | 42,2 | 3,6 | 3,38 | 3,6 | 3,38 | | | 4,9 | 4,46 | 4,9 | 4,46 | | | 6,4 | 5,6 |
| 11/2" | 40 | 48,3 | 3,7 | 4,05 | 3,7 | 4,05 | | | 5,1 | 5,4 | 5,1 | 5,4 | | | 7,1 | 7,23 |
| 2" | 50 | 60,3 | 3,9 | 5,43 | 3,9 | 5,43 | | | 5,5 | 7,47 | 5,5 | 7,47 | | | 8,7 | 11,1 |
| 21/2" | 65 | 73 | 5,2 | 8,62 | 5,2 | 8,62 | | | 7 | 11,4 | 7 | 11,4 | | | 9,5 | 14,9 |
| 3" | 80 | 88,9 | 5,5 | 11,3 | 5,5 | 11,3 | | | 7,6 | 15,3 | 7,6 | 15,3 | | | 11,1 | 21,3 |
| 31/2" | | 102 | 5,7 | 13,6 | 5,7 | 13,6 | | | 8,1 | 18,6 | 8,1 | 18,6 | | | | |
| 4" | 100 | 114 | 6 | 16,1 | 6 | 16,1 | | | 8,6 | 22,3 | 8,6 | 22,3 | 11,1 | 28,3 | 13,5 | 33,5 |
| 5" | 125 | 141 | 6,6 | 21,8 | 6,6 | 21,8 | | | 9,5 | 30,9 | 9,5 | 30,9 | 12,7 | 40,2 | 15,9 | 49 |
| 6" | 150 | 168 | 7,1 | 28,2 | 7,1 | 28,2 | | | 11 | 42,5 | 11 | 42,5 | 14,3 | 54,2 | 18,3 | 67,5 |
| 8" | 200 | 219 | 8,2 | 42,5 | 8,2 | 42,5 | 10,3 | 53,1 | 12,7 | 64,6 | 12,7 | 64,6 | 18,3 | 90,7 | 23 | 112 |
| 10" | 250 | 273 | 9,3 | 60,2 | 9,3 | 60,2 | 12,7 | 81,5 | 12,7 | 81,5 | 15,1 | 95,8 | 21,4 | 133 | 28,6 | 172 |
| 12" | 300 | 324 | 9,5 | 73,8 | 10,3 | 79,7 | 14,3 | 109 | 12,7 | 97,4 | 17,4 | 132 | 25,4 | 187 | 33,3 | 239 |
| 14" | 350 | 356 | 9,5 | 81,2 | 11,1 | 94,3 | 15,1 | 126 | 12,7 | 107 | 19 | 158 | 27,8 | 224 | 35,7 | 281 |
| 16" | 400 | 406 | 9,5 | 93,1 | 12,7 | 123 | 16,7 | 160 | 12,7 | 123 | 21,4 | 203 | 30,9 | 286 | 40,5 | 365 |
| 18" | 450 | 457 | 9,5 | 105 | 14,3 | 156 | 19 | 206 | 12,7 | 139 | 23,8 | 254 | 34,9 | 363 | 45,2 | 459 |
| 20" | 500 | 508 | 9,5 | 117 | 15,1 | 183 | 20,6 | 248 | 12,7 | 155 | 26,2 | 311 | 38,1 | 441 | 50 | 564 |
| 22" | 550 | 559 | 9,5 | 129 | | | 22,2 | 294 | 12,7 | 171 | 28,5 | 373 | 41,3 | 525 | 54 | 671 |
| 24" | 600 | 610 | 9,5 | 141 | 17,4 | 255 | 24,6 | 355 | 12,7 | 187 | 30,9 | 441 | 46 | 639 | 59,5 | 807 |

*Table 14 - IACS – Requirements concerning Pipes and Pressure Vessels – Corrosion Allowance*

| Piping service | c (mm) |
|---|---|
| Superheated steam systems | 0,3 |
| Saturated steam systems | 0,8 |
| Steam coil systems in cargo tanks | 2 |
| Feed water for boilers in open circuit systems | 1,5 |
| Feed water for boilers in closed circuit systems | 0,5 |
| Blow down (for boilers) systems | 1,5 |
| Compressed air systems | 1 |
| Hydraulic oil systems | 0,3 |
| Lubricating oil systems | 0,3 |
| Fuel oil systems | 1 |
| Cargo oil systems | 2 |
| Refrigerating plants | 0,3 |
| Fresh water systems | 0,8 |
| Sea water systems in general | 3 |

NOTE
1. For pipes passing through tanks an additional corrosion allowance is to be considered according to the figures given in the Table, and depending on the external medium, in order to account for the external corrosion.
2. The corrosion allowance may be reduced where pipes and any integral pipe joints are protected against corrosion by means of coating,, lining, etc.
3. In the case of use of special alloy steel with sufficient corrosion resistance, the corrosion allowance may be reduced to zero.

After fabrication, pipes can be tested to their test pressure with the Hydrostatic testing method. The working pressure of the line is important for testing pressure.

Test pressure values can differ differently depending on class society acceptance criteria. From the new building, all test pressure values of the pipes were recorded to vessel certificates. One of the critical things of that test is to check and correct other equipment and fittings (valves, flanges, couplings, etc.) on that line.

**SCRUBBER OVERBOARD LINES (AFTER THE OVERBOARD VALVE):** The pipe's thickness needs to be min. Shell plate thickness or 15 mm. (thicker one). Must be clarified with the class surveyor in advance. Also, additional corrosion protection precautions need to be followed by the yard. (Chemco RS 500P + RA 500M ~1200 micron)


*Figure 120 - Scrubber Line and Overboard Protection with Chemco Glassflake Systems*

If special material welding is needed during the dry dock, the superintendent must clarify with a yard for certification and procedures. Some special welding (boiler tubes, particular type stainless steel, etc.) needs approved welders and procedures, which may create huge costs in just a few meters.

*Figure 121 - Special Grade Pipe Welding in Yards*

Prefabrication and welding in the workshops (inside the yard) are critical items for on-time projects, which may save huge budgets with early departure and also can reduce the workmanship of the yard, making it easy to plan.

Collecting waste (oily) water is also essential for cargo line testing. Before testing, all preparation must be managed by the yard and ship-owner to collect that oily water.

Also, all valves must be checked and fixed at open condition until the last testing point. When the line is full of water, the connection of the pressure equipment valve is closed; if possible, the connection point of the Waterjet is removed from the main line, and the system can wait around 1 hour in pressurized conditions. Even if it is a fire line, cargo line, marpol line, or others, pressure can show with the valve opening after completion of the test.

For details: **IACS: Requirements concerning – PIPES AND PRESSURE VESSELS** or class rules.

*Figure 122 - Prefabrication of Pipes for BWTS and Scrubber Projects (TK Tuzla)*

*Figure 123 - Pressure Testing of Lines (Hydrostatic Tests)*

## Section 4.01 Steel Pipe Renewal – Drawings – Calculations

After completion of pipe markings before renewal works, lines must be checked free from any liquid (seawater, fresh water, sewage, fuel oil, etc.) for safety or free from any operations (hydraulic lines – windlass, etc., ballast line – docking & undocking or shifting) during the repair periods. For that reason, during the repair period, vessel and yard teams must carefully check this material.

*Figure 124 - Pipe Fabrication in Workshop*

The pipes' drawings (marked by the vessel team or class surveyor) must be confirmed by the vessel representative (for budgetary purposes, etc.). For that reason (not to create any future problems), yard design teams must draw all the marked lines ASAP. Then, the vessel superintendent (or class surveyor) can confirm the marked area on drawings and check the pipe's schedule (and thickness); if there are modifications, all parties can check the actual dimensions initially. There can be an additional line renewal process (corrosion can be seen better after removing the marked area) or modifications during the renewal. These modifications must be added to pipe drawings as a revision.

These drawings are prepared for the owner to check and calculate the work budget and for yard teams to complete their workshop (prefabrication) and onboard fabrications.

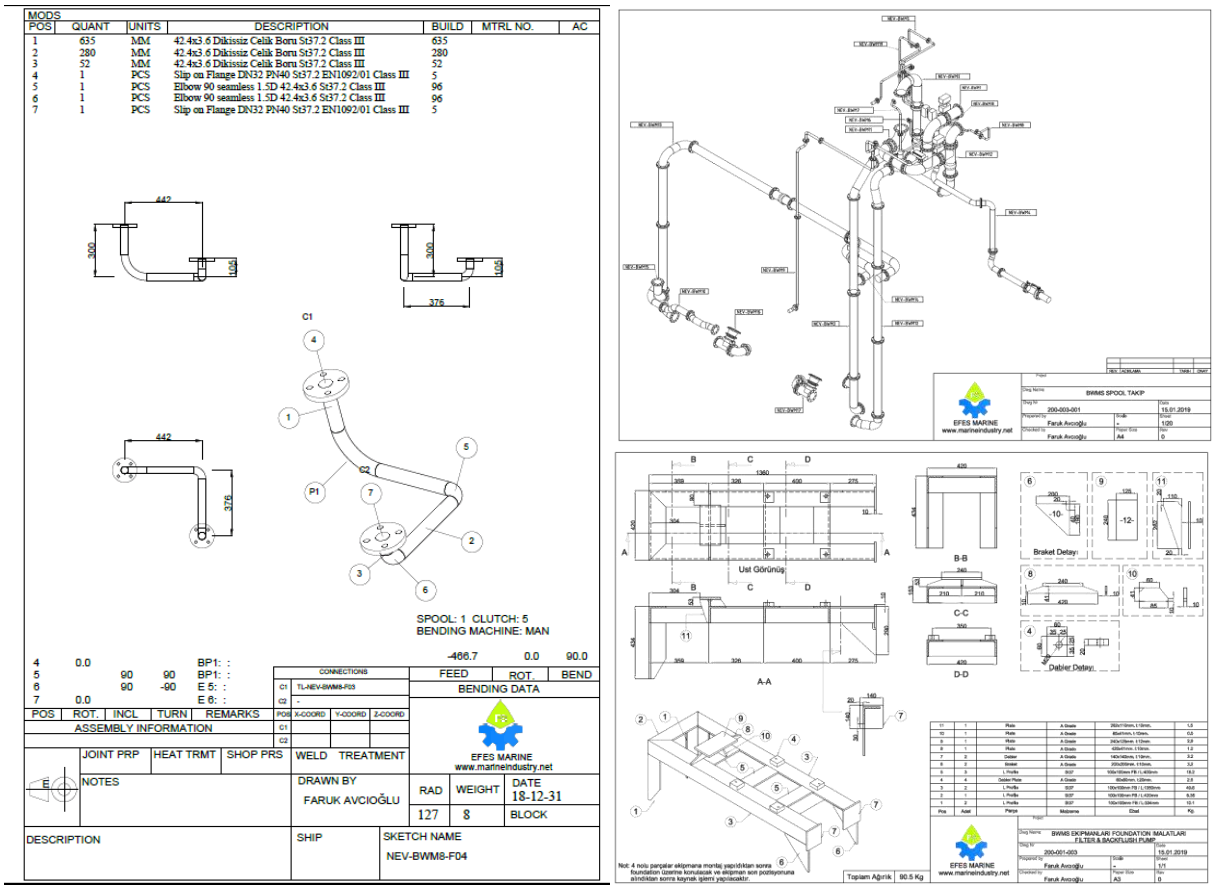



*Figure 125 - Pipe Drawings for BWTS System (Together with Foundation) for Turkish Shipyard*

Regarding length calculations, most of the yards have a different calculation mentality. But if we wish to understand the most known items.

| Yard Rules | Explanation |
|---|---|
| Pipes less than 1m length is calculated as 1m pipe | The minimum length of the renewed pipe between 2 welding seams or/bends will be charged as 1 meter. |
| 1 pc. elbow up to 8" = 1m pipe<br>1 pc. Elbow 8" – 12"= 2m pipe | The quantity of the elbow (up to 8") will be collected and charged as 1 meter of the same length pipe price. (These items can change according to the yard quotation system. Some yards charge with a unique elbow price.) |
| Penetration pieces (Deck or bulkhead) will be 35% extra of same size of 1 meter pipe. | Each penetration piece will be charged as 0.35 x 1 meter of pipe (passing through the penetration/bulkhead) price. |
| Access pipes to be charged 50% extra. | All access lines that must be removed for pipe, valve, or other works must be measured and charged 50% of pipe prices. The calculation of length will be the exact dimension. |
| SCH80: 100% more than SCH40 | For SCH40 pipes, prices are standard as per the pipe price list. If thicker pipe is required, like SCH 80, the price will be multiple with size factor. |
| Location factor for engine room, pump room: 25%<br>Location factor for tanks, cargo holds: 30% | All yard quotations give standard renewal prices for deck pipes. If the pipe is in the engine room, pump room, ballast tanks, etc., unit prices must be multiple with location factors. |
| Galvanizing: 25% | Additional coating applications can separate prices, or coefficient coating factors can be used for pricing. |

**Note:** If there are some combined factors in the calculation (Pipe in the engine room (25%), Galvanized (25%) and SCH80 (100%)) they must be calculated with SUM (Unit price x 2.50) of factors not MULTIPLE (Unit price x ~~3.125~~).

## Section 4.02 Pipe cleaning & coating works in-situ

Corrosion on seawater lines (ballast, cooling, etc.) is one of the big headaches for vessels, which can affect the engine's performance or create a problem on ballast–cargo operations due to corrosion or biofouling effects. Those lines were manufactured during the new building period, and after installing other systems, removing them without other lines or outfitting access operations is nearly impossible.

*Figure 126 - Pipe Internal Cleaning and Coating Application via Robots*

Nowadays, some water jetting systems can manage pipe cleaning works in – situ, and then you may have a chance to apply epoxy coating on the lines without removing complete systems. Barnacles and muscles can block the line, and the vessels will have the opportunity to manage cleaning work during the yard period. Especially unreachable areas like cross-over pipes or cooling lines can be cleaned with that kind of systems.

## Section 4.03 Heating coil renewal works

Heating coils are mainly used for fuel oil tanks, crude oil tanks, etc. The material of the pipes is primarily stainless steel for primary deck penetrations and copper-nickel alloys for main lines inside the tanks.

Repair of those lines is a hard job for yards and vessels. Before starting work, cleaning the tanks for hot work is very important. If the pipes also have holes inside those lines, they must be drained, and a gas-free inspection must be completed.

*Figure 127 - Heating Coil Welding*

The welding of those lines can be managed with very expensive silver electrodes. That welding method must be followed carefully, and after welding works, the line must be tested on its test pressure.

For Al – Br (Heating coils, etc.) material welding works, superintendents must be very careful about material supply, WPS – WPQR of the yard, and pricing. Also, after completion of the works, all parties must consider the testing period, which may take 1 – 5 days depending on welding quality and the description of leaking locations in advance.

## Section 4.04 Hydraulic Lines Renewal Works

Hydraulic line renewals are the most competitive works for pipe works. These are high-pressure lines used for valves, cranes, windlass, etc. With that kind of line, pipes, and connections must be checked carefully.

*Figure 128 - Hydraulic Fittings*

For cargo hydraulic lines (stainless steel – ~10 mm inner diameter), the renewals of the lines can be managed with stainless steel unions without any hot works inside the tanks.

During that renewal work, removing existing lines and connecting new lines must be managed very carefully. Those lines are hydraulic lines and work with huge pressures. Any small particulars can create big problems during the valve and windlass operations. For that reason, lines must be kept in blind condition during the renewal process, and after that, there must be some aside cleaning process (up to 48 hours – flushing) to ensure there is not any dirt inside of the lines, which can create problems.

*Figure 129 - High Pressure Hydraulic Pipe Fabrication*

## Section 4.05 GRE – GRP Pipe Installations

Due to scrubber and ballast water treatment system installations, GRE/GRP type pipe installations are increased. Some systems needed chemical additives for treating seawater for BWTS systems or during removing NOx – SOx from the air. They need to use some chemicals in washing water lines or chemical lines, and they need to use that type of pipe.

The critical points for pipe installations are.

1. Approval of the pipe from manufacturer and class society,
2. Pressure class of the pipe,
3. Applicator certification and experience during the installation,
4. Glue/resin application for connection pipe (Leak-free, but also the inner side of the connection points must be free from glue due to back pressure effects for small diameters – especially for sensitive chemical lines),
5. Support installation and vibration estimations,
6. Lines need to be straight as much as possible (less elbow or flange connection),
7. Testing and inspection of the line (Even fabricated pipe or elbow may have leaks – original parts),
8. Installation of drip tray for chemical spill risks for critical points.

*Figure 130 - GRE & GRP Pipe Fabrication and Inspections*

During the tests, critical areas are not just connection points; also, during the fabrication process, some things may be improved. So, all the lines must be inspected with proper methods and tools.

*Figure 131 - GRE Pipe Heat Curing Process*

That kind of glue connection is more stable with proper heat-curing applications.

## Section 4.06 Special Type Pipe Repairs

### (a) Epoxy repairs & coating application,

A combination of epoxy resins and fiber fabrics can used for pipe repairs and as a corrosion protection system. According to pipe working pressure and temperature, that system can solve leak and corrosion problems temporarily or permanently.

*Figure 132 - Application of Cold Repair System on GRP – GRE Pipe Samples*

### (b) Polyester repairs on pipe

Polyester applications on pipes are mainly used to save from heat transfers and anticorrosion effects from seawater or direct sunlight. Different coating systems can be used on the main deck or some cooling line.

### (c) Pipe insulation applications

Pipe insulation systems can be managed onboard with a different system. For commercial vessels, insulation of the pipes can be with thermal blankets or insulation materials with galvanized steel sheet covers.

All insulation materials have a certificate for the line, which the class society requests. According to the vessel insulation plan, these certificates can be A0 – A30 – A60.

*Figure 133 - Pipe Insulation Jackets*

### (d) Pipe galvanizing,

Due to corrosive effects, pipes need to be coated properly, for flat surface galvanizing can be managed with electro–galvanizing. But pipe or another type of construction electro–galvanizing methods can't be followed due to unreachable areas.

For that reason, for ballast lines, most corrosive locations need to be coated with the hot dip galvanizing (HDG) method if the diameter of the pipe is less than 150 mm (above that, epoxy coating can also be applied). HDG is the coating made by dipping the steel products into zinc liquid, melting at nearly 450 °C, after the surface preparation steps. Thus, all product surfaces, even the closed volumes, are covered with zinc. Zinc has a durable structure and makes a metallurgical bond with steel. It sacrifices itself to corrosion, and for this reason, it extends the lifetime of the steel.

If the pipes are in dirty condition (oily, rusty, shop primed, etc.), the galvanizing surface must be cleaned with a proper method like acid cleaning. After galvanizing, pipes can be coated with some polyurethane or epoxy coating system to extend the life cycle of the construction up to 100 years.

Even If the storage or transport of the pipes is not in good order, most of the damages will occur on the outer side of the pipe, so these galvanized damages can be repaired with special epoxy paints like Chemco RL 500PF (Compatible with galvanized structures) with crew or yard workers.

*Figure 134 - Pipe Galvanizing*

*Figure 135 - Repairing (Coating) of Galvanized Pipes with RL 500PF + RA 500M Glassflake*

*Figure 136 - Prefabricated Galvanized Pipes at Yards*

### (e) Glassflake epoxy & rubber coating of the pipes – inside and outside

On vessels, some pipes are very critical parts of the systems. Cooling lines, ballast lines, sewage, or dirty water lines are the most critical locations for corrosion.

During the sailing period or berth repairs, the repair team can't have a chance to remove the pipes from their locations. So, mainly ballast pipes or cooling lines can be removed and repaired during docking (~7 days).

Also, for chemical transfers or scrubber & BWTS overboard pipes, it is possible to use those coating systems due to their high resistance against acidic environments.

*Figure 137 - Rubber & PP & PE Coating of Pipes*

So, if there is no hole in the pipes, there can be some permanent solutions with coating systems. Pipes must be blasted/water jetted properly, and then pitting must be filled with some ceramic fillers. After completion of pitting repairs, the surface must be coated with primer + glassflake topcoat. Together with Ballast Water Treatment systems, our suggestion is clear: all new lines must be coated with the proper system as per paint manufacturer instructions. The below coating system can be used during the renewal works.

**Suggested System:**

**Internal Pipe Coating:** Blasting/Waterjetting/Grinding + RS 500P + RA 500M

### (f) Steam Lines

Steam line temperatures can be changed to **80°C – 150°C** during the vessel's sailing, which creates particular types of corrosion (Corrosion Under Insulation - CUI) on those lines. Due to condensation and other effects, corrosion can start under the insulations (CUI).

Those lines directly affect cargo operations, so protection against corrosion and insulation is critical.

Standard epoxies can resist up to 80°C, and they need SA 2½ surface preparation together with the perfect application. Still, it starts to fail after a few months, and those lines are critical in the main deck condition. The costs of that failure are not just coating repair; it also means hot work on lines and renewal of insulation, which can cost 3X – 4X pipe renewal prices. On tankers, except for special survey periods, hot work in the main deck area is a nightmare, which can be managed in fire-free conditions of related areas (cargo lines, tanks, etc.).

In those lines, Chemco RL 500 PF is one of the unique solutions for heated lines. The product can resist up to 150°C and be applied on galvanized or water-jetted surfaces. Even crew maintenance can be used after grinding and washing with fresh water. The critical thing will be the coating thickness and filling of pitting and bolted areas via brush.

*Figure 139 - Corrosion Under the Insulation and Coating Protection with Chemco RL 500PF*

*Figure 138 - Chemco RL 500PF Application on Heated Lines*

# Article V. VALVE WORKS

## Section 5.01 Overboard Valve Overhauls

During the special and intermediate surveys, overboard valves are one of the inspection items for class surveyors. Some butterfly valve cleaning can be managed from overboard without any valve removal and access pipes (Larger than DN 250, etc.).

*Figure 140 - Valve Overhauling in Shipyard Workshop*

Sewage overboard, galley overboard, or ballast overboard valves are critical for inspections. The vessel can supply a class-approved overboard valve spare if there is some suspicious condition expectation before docking. For renewal, all overboard valves must be class-approved. If the valve has no class approval, then one valve can be supplied from an approved manufacturer, and pressure tests of the valve can be carried out with a witness of the class surveyor. In that scenario, the class surveyor will ask the manufacturer for workshop approval.

IACS societies can request that tests to be sure about the valve condition. Approvals are ultimately commercial and technical items, and all parties need to save their customers' rights.

After cleaning, valves must be painted with one of the epoxy systems. Grid blasting can damage the seats and rubber packing, so for that reason, rust-tolerant products can be applied.

*Figure 141 - Overboard Valve Overhaul Onboard*

**Suggested System:** Chemco RS500 P + RA 500M Glassflake final coat (Cost for m² ~around 10$ - approx. 5 – 20 pcs valve)

## Section 5.02 PV & Safety Valve Overhauls

PV (pressure and vacuum) valves are tankers' safety points, affecting loading operations. As a standard class item, the yard can do valve overhauls, and tests can be carried out in the yard shop. As an initial precaution, magnets or seat systems can be checked before the entrance of the drydock. Types and maker details can be shared with the yard before arrival.

Especially boiler or heating system safety valves can be checked during the drydock. These are the class

*Figure 142 - PV Valve Overhaul & Protection*

item valve inspections that can be overhauled in yard workshops. Workshop tests can be done, but most surveyors want to check operational tests after starting the boilers.

# Article VI. CORROSION PROTECTION & COATING WORKS

The general structure of commercial vessels is steel, so the biggest challenge of shipping is corrosion protection on board. Most of the corrosion type can be seen onboard during the inspection. General corrosion is the biggest challenge for holds, tanks, decks, etc., and paint application is the main solution to that problem. In addition to paint application, ICCP, anodes, galvanizing, etc. can used for additional support for protection.

## Section 6.01 Hull Coating Applications

The vessel hull coating process is one of the biggest challenges for shipyards, coating manufacturers, and ship owners. The hull coating process can be managed during the dry-docking, and in most cases, it directly affects the docking day of the vessels. Docking is the most expensive case (parking way) for ships and shipyards. Repair yards can make money during the docking period. For that reason, hull coating is one of the biggest challenges for shipyards.

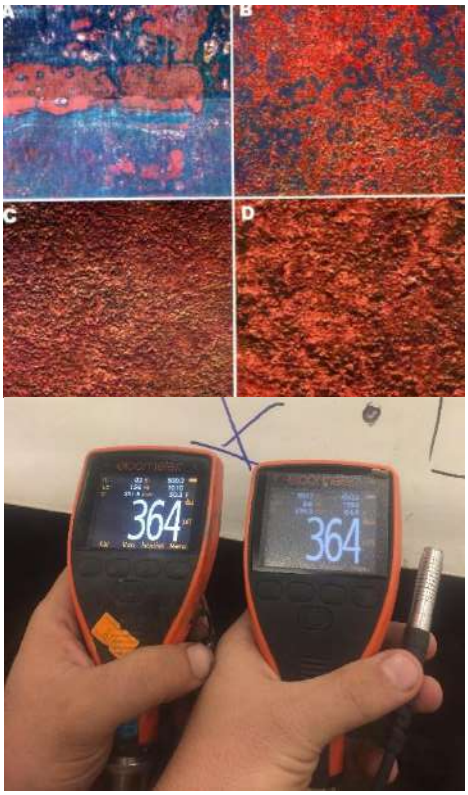


*Figure 143 - Hull Condition & DFT Checks*

Grid blasting of the hull can be managed mainly with 4 – 5 scenarios by the ship owner.

1. Failed coating systems or system changes: %70 – 100 of the hull can be blasted with SA1 – SA2 to reach a good surface and strong coating condition. It takes more time and budget. In most cases, this system usually is not needed.
2. Spot blasting of vessel: For rusty areas, the ship can do some spot blasting to prepare good surface areas, and if the coating condition of the other areas is good, usually, there is no need to make any surface preparation (sweeping, etc.). With that system, minimum time and budget can be managed. The agreement about the percentage is so critical for budget management. In this case, all sides of the contract (ship-owner & shipyard) must be fair. The major percentage (global fleet) of surface preparation for hull blasting is that system.
3. Mixed blasting systems: Some types of vessels need extra coating properties. For fuel saving, the vessel's vertical side and boottop side can blast full SA2, and the other locations can blast as a spot.
4. Clean surface (Without blasting): After waterjetting if there is no any major rust on hull (less than 5% and minor location) if the primer is acceptable (rust tolerant) directly coating can apply on some minor rusty surface and coating process can followed without any grid blasting.

*Figure 145 - Hull Fouling*

**5.** Waterjetting or washing of hull: Depends on yard equipment park, waterjetting & water blasting can option for ship-owners. If the hull is clean and vessel is in slow speed range, waterjetting (up to 1000 - 1500 bars - Helijetting) can option for removing barnacles, rusts and weak paint from surface. Nowadays, coating industry has surface tolerant systems, which can apply water-jetted surfaces. If the barnacles are the critical problem on the surfaces at the beginning, water washing of the surface must be done min. 500 bars with orbital nozzles (www.mvt.ch).

*Figure 144 - Barnacle Invasion on Hull*

Orbital nozzles' working mentality is using the rotational power of water. It will be more powerful if you compare it with flat nozzles. Sometimes, shipyards would like to use flat nozzles to reduce the consumables costs with a wrong calculation of purchasing departments. After water jetting, if the roots of the barnacles remain on the surface, minimum SA1 needs to be done to remove those roots that may have some salt content. After that, salinity needs to be checked. If additional hose-down is required, that will be an additional cost for the owner and shipyard and may affect the docking days. For that reason, if the vessel has some barnacle problems before docking, the shipowner side needs to decide the primer for the worst-case scenario. So, the primer must be surface-tolerant (for flush rust, etc.).

**First Hull Washing:** Orbital Nozzles ~ 500 bars with a min. ~30 liter/washing gun with Monrojet Orbital Nozzles.

**Hose Down:** Flat Nozzles ~200 bars with ~25 - 35 liter/washing gun

As per the coating condition assessment, blasting of the hull ratio can change if the rust is localized or scattered. In localized conditions, blasting areas can be 10 – 20 more than rusty areas, but in scattered conditions, it can double, triple, or more.


*Figure 146 - MVT Orbital Nozzles for Hull Washing & Onboard Maintenances*

Turbo nozzles are one of the most powerful tools for water jetting and blasting options for hull or tank washing. The efficiency of those nozzles is higher than that of standard nozzles, but the usage area is generally for corrosion protection and surface preparation works. For traditional hull washing, orbital nozzles can be more practical.

On decks or inside the tanks, etc., turbo nozzles can be a better option due to their sapphire nozzle inserts and also that nozzles can remove rust and paint better than other types. If we compare orbital and turbo nozzles with the same capacity of pumps (500 bars 35 liters, i.e.), recoil forces on turbo nozzles are less than those of orbital ones. So, workers' efforts are less when using turbo nozzle systems on their waterjets.

For the onboard maintenance process, there are several options for waterjet selection. Critical items for onboard repairs will be the safe application and performance of the waterjet. With nozzles selection criteria, up to 500 bars waterjet, pump capacity must be min. 30 liter/minute. Lower capacities performance values are so low.

*Figure 148 - Safety Protection Clothes for Workers*

*Figure 149 - Waterjet for Onboard for Maintenance*

**Suggested Machine Capacities:**

500 bars – 30 lt/min. 1000 bars – 16 lt/min. 2000 bars – 8 lt/min.

I.e., in 15% of scattered rust ratio, blasting can be a minimum of 30 – 40% of the total area, and first coat painting can be ~60 – 70% of the area.


But in 15% localized rust condition, blasting can done 17 – 20%, and first coat painting can apply 20 – 22% of the total area. The ratios show that the blasting budget and paint consumption change according to rust locations and vessel conditions.

As you can see below, the hull blasting application rust ratio is around ~30% of the area, but the blasting (SA2+SA1) ratio will be completed by more than 70%.

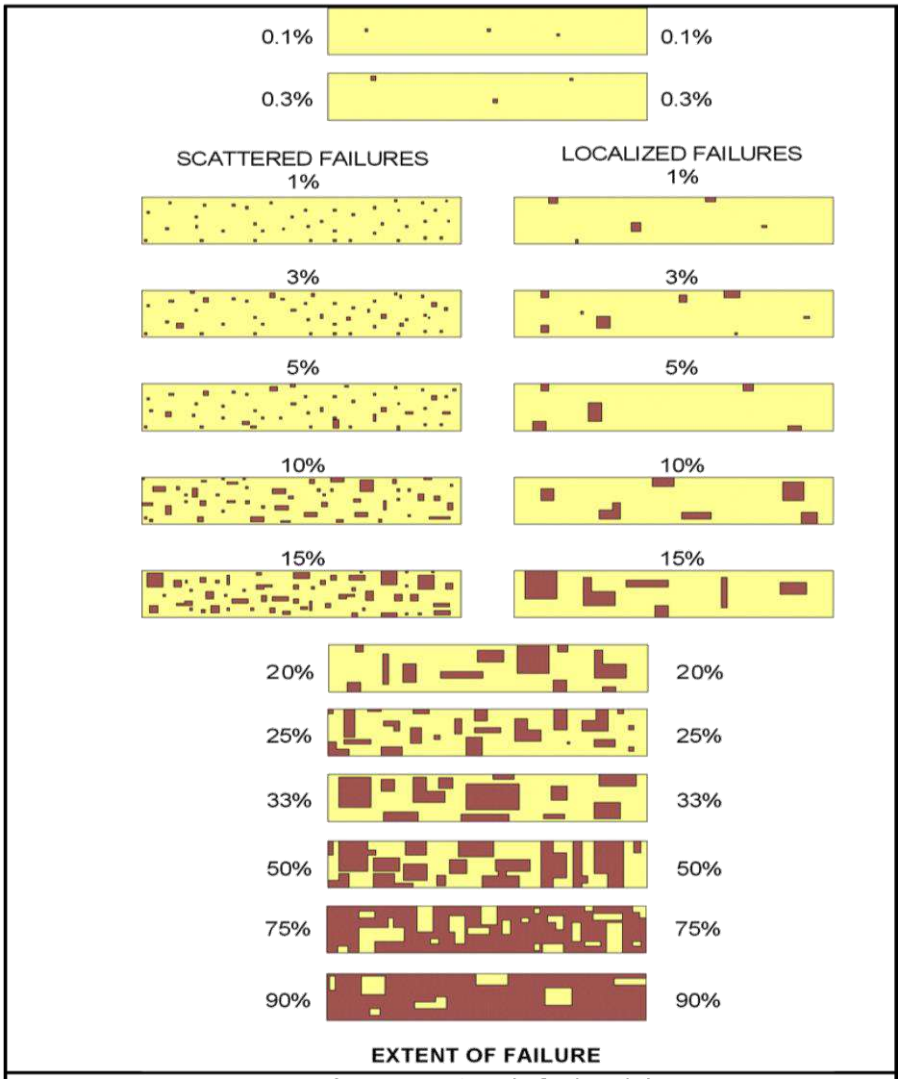



*Figure 150 - Assessment Scale for Breakdown as per IACS*


*Figure 151 - Hull Condition Before & After Blasting*

Therefore, paint consumption directly relates to the blasted areas and scattered painting locations. For the above picture, the painting area is nearly 90% of the area. Consumption of primer must be calculated as per the final blasting condition.

*Figure 152 - Hull Blasting Application Depends on Surface Condition (Same Location)*

Again, the rust ratio is around 10% in that picture, but the blasted area (SA2) is more than 30% of the location. Painting can be about 60% for primer. Also, If the surfaces have some profiles (fenders, chocks, etc.), this will affect consumption. During the paint order process, additional paint drums need to be calculated.

If superintendents see that blasting of the hull will be nearly complete, they need to order coating products 100% of the area from primer to top coat. Even with a high percentage of the blasting ratios, some strong primers can stay on the surface, but because of grit damage, these areas will be affected, and the sprayer will apply a very thin layer to that damage. So, with fewer orders, the thickness of newly blasted surfaces will also be reduced.

*Figure 153 - Blasting of Topside & Boottop & Vertical Side*

As a coating inspector and naval architecture & marine engineer, for vessel efficiency and fuel oil consumption environment, etc., If the vessel can make some high blasting ratios on the boot top & vertical side, full SA2 will be very helpful for the following year. The topside is decorative, and you can apply whatever is needed, not more. For flat bottoms, the priority is corrosion protection, not more.

During the paint ordering process, the vessel's superintendent needs to decide what his target for paint application is and discuss with the manufacturer's coating inspector and yard paint inspector to clarify paint usage. After blasting the hull, the yard will have a couple of hours, which may need more to supply additional orders.

As you can see, during the spot blasting, it is easy to say that nozzles are giving damage to the strong coating. These damages need to be protected with a layer of primer. The spot percentage of the pictures is around 5 – 10%, but painting can be a minimum of 30 – 40%; the suggestion ratio is about 60% for the below pictures.

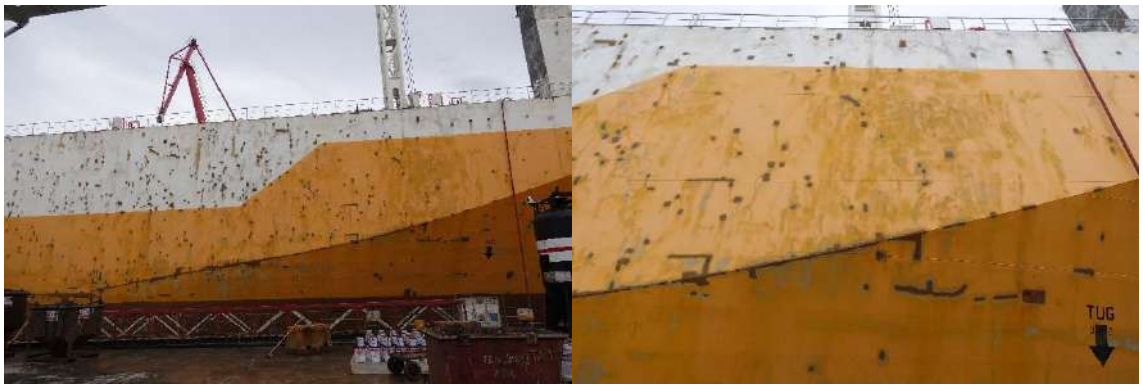



*Figure 154 - Hull Blasting Damages with Spot Blasting*

For the marking of the hull, topside area polyurethane (2 Component – 2K products) can be used; for underwater areas, alkyd (1 component) products will be a strong option. If you use 2 K products on top of 1K products (like antifouling, etc.), strong products (2K) will react with 1K products during the curing process. So underwater markings will go away.

*Figure 155 - Plimsoll Marks & Multiple Load Line Marks*

For multiple load line markings painting, one set of lines must be painted with visible color. White or black can be selected depending on the hull's general color.

Coating technologies can cover surface preparation with water-jetting or other commercial methods. These surface preparation methods are additional investments for yards. Still, in the end, with that improvement method, the shipowner will have a chance to protect their sensitive equipment onboard and can manage steel, shaft, or other hull–open deck works during the hull surface preparation period. This will save money and time for both parties and earn a clean environment and healthy workers.

## Section 6.02 Shipyard 4.0 for Surface Preparation & Coating Applications

Nowadays, with improvements in water blasting technologies, safe, environmentally friendly, and cost-effective ways of surface preparation are robotic systems. Risk factors are fewer, and washing

water can be used after filtering with a vacuum (Costs are higher than the desalination process, so treated water can be pumped to the sea, and fresh seawater can be used for freshwater supplies). Coating technologies can be applied on those surfaces (flush rust, etc.). For yards, it is easy to coordinate the work with other docking works, and all hull coating processes can be managed with less workforce & waste materials.

Since 1980, grid blasting technologies have been the unique solution for huge areas. With improvements, water blasting systems are now in the game-changer category. All yards have established systems with compressors for grid blasting; it is old but working. New investments will likely be in the water jetting industry. With this mentality, superintendents, paint inspectors, yard engineers, and workers will re-educate their skills for new systems shortly. The coating industry and robotic systems already have enough innovation and production volumes for that revolution.

### *(i) Robotic Systems for Waterblasting*


*Figure 156 - Shipyard 3.0 & 4.0 Applications*

Waterblasting is the unique solution for hull blasting applications for efficiency, speed, pollution, and cost-effectiveness for 2020. If we compare grid blasting and water blasting systems,

- With one robot, water-blasting speeds can reach 50 – 100 m²/h, and grid-blasting speeds are approx. 6 – 10 m²/h,
- Shipyard surface preparation costs are ~20 – 40% less than grid blasting,
- For spot blasting, there can be a clear option like helijetting,
- Paint manufacturers are also supporting water-blasting for hull coating applications.
- Process water can be filtered and reused during the washing/water blasting.

- Contaminated paint can be separated after washing with mechanical or chemical filtering systems.


*Figure 158 - Helijetting System by Falch (1500 bars) Spot Blasting (WJ3 - WJ4 ~ SA1 + Sweeping)*


*Figure 157 - Waterblasting by Falch (3000 bars 45 liter) WJ1 - WJ2 (~SA2 - SA2½)*

The definition of the surface will be the most challenging discussion point for shipyard & coating manufacturer & shipowner representatives. All parties will not generally be experts in the water blasting process, which is also expected.

However, due to environmental limitations, CO2 limitations, and commercial issues, water blasting with robotic systems is now the future of our industry. So, approved solutions need to be agreed upon by all parties without sacrificing quality, docking period, and environment.

*Table 15 - Surface Preparation Standards*

| ISO 8501-1 Dry abrasive blasting | NACE Dry abrasive blasting | NACE Wet abrasive blasting | SSPC Dry abrasive blasting | SSPC Wet abrasive blasting | ISO 8501-4 Water jetting | NACE 5 / SSPC 12 Water jetting |
|---|---|---|---|---|---|---|
| Sa 3 | 1 | WAB 1 | SP-5 | SP-5 WAB | | WJ-1 |
| Sa 2½ | 2 | WAB 2 | SP-10 | SP-10 WAB | Wa 2½ | WJ-2 |
| Sa 2 | 3 | WAB 3 | SP-6 | SP-6 WAB | Wa 2 | WJ-3 |
| | 8 | WAB 8 | SP-14 | SP-14 WAB | | |
| Sa 1 | 4 | WAB 4 | SP-7 | SP-7 WAB | Wa 1 | WJ-4 |

### *(i) Suggested Waterblasting System for Yards (10.000 $m^2$ for 48 hours)*

There are established compressed air systems for shipyards that are easy to manage. Also, temporarily, you can increase that capacity with rental compressor options without any problem. Two major players worldwide are operating turnkey ship hull blasting with robotic systems for 100% of the surfaces, together with their pumps and tools. As a dealer of www.falch.com, I would like to summarize their system, which has a unique – high-speed solution for spot blasting.

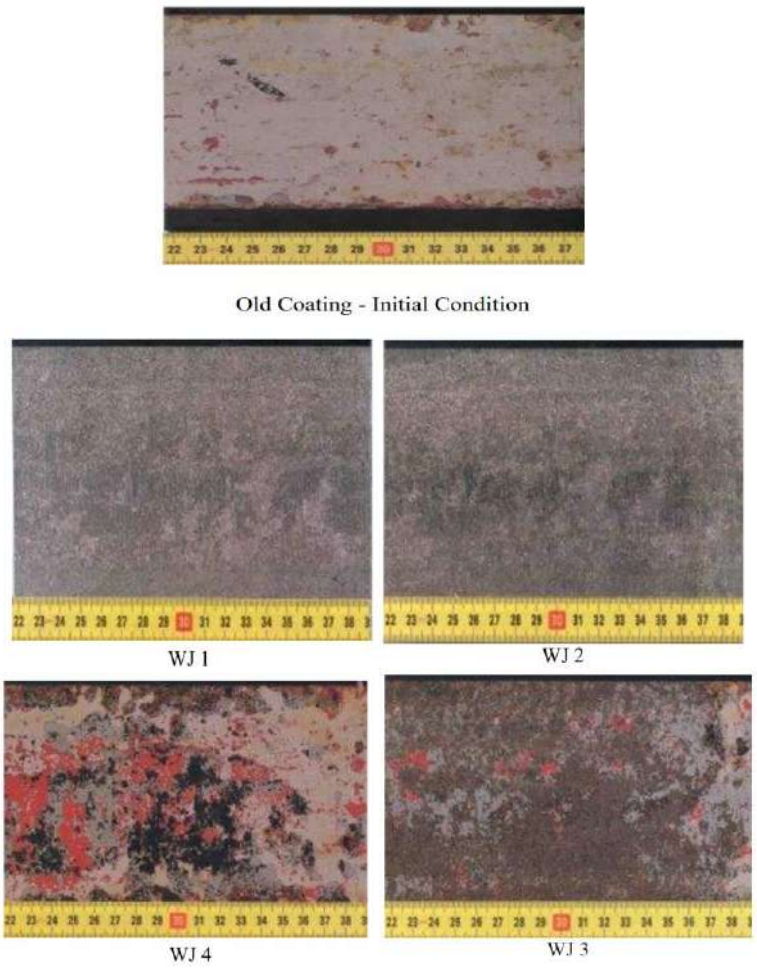



*Figure 159 - Surface Preparation Photo Checks (SSPC)*

*Figure 160 - Surface Preparation Detailed Picture*

1) Extra high quality washing of hull before waterblasting or sand blasting – **Helijetting 500 bars**

With Helijetting systems, at 500 bars, all barnacle roots, slime, weak paint, and other residues can be removed from the surface due to its rotating turbo nozzle systems.

After washing, there will be no salt or barnacle root problem for the shipyard or shipowner, and together with that system, the shipowner or coating inspector can decide the needed grid blasting or water blasting ratio. During that washing system, the turbo nozzle of the head has a standard distance from the surface, so it scans every $cm^2$ of the surface.

Helijetting can reach 800 $m^2$/hour efficiency and high surface quality with low freshwater usage.

*Figure 162 - Manuel Hull Washing (Unsafe – Low Efficiency and Low Quality)*

*Figure 161 - Helijetting for Hull Washing @500 bars*

### 2) Spot Waterblasting on Hull (~SA1 & Sweeping) – Helijetting Technology 1500 bars

Hull spot water blasting is one of the biggest problems of water blasting technologies. Up to now, most shipyards are trying to solve that problem via manual guns, but it is very slow, and the cost of m2 is sky high (approx.. 30 – 60 Euro/m2), which can not be afforded by the shipowners or shipyards. The system's efficiency is also very low; one person can start the manual gun water blasting with 6 – 8 m2/hour, and after some hours, efficiency can be reduced by 2 – 3 m2/hour; of course, safety risks are increasing so high.

With the Helijetting 1500 bars system, ~400 m2/hour surface can be scanned fully, and rusty areas can be removed up to bare metal; all weak paints can also be removed from the surface.

With two pumps and robots, the shipyard can manage ~15000 m2 area to ~SA1 & Sweeping per 18 hours (day). That performance can help the shipyards and owners avoid delays in their schedules.

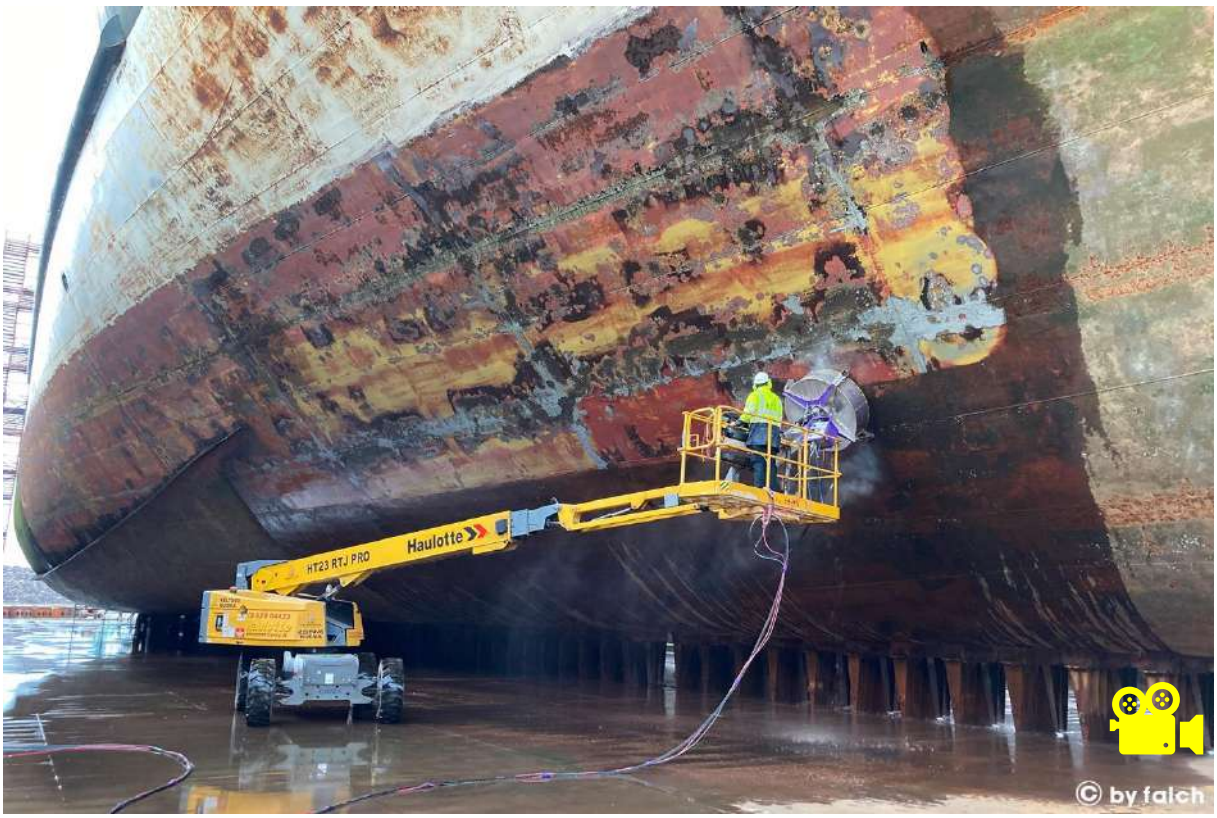



*Figure 163 - Hull Spot Blasting with Helijetting 1500 bars*

### 3) Full Hull Blasting – (~SA2 – 3000 bars 45 liters) – Lift Worker Beam 250 & Surface Rob 250

The complete blasting of the hull performance is related to the pressure and capacity of their pump and nozzle structure. In Falch systems with high flow capacity, you can reach up to 90 m2/hour on the hull for complete blasting. As you can see from the videos, the equipment is compatible with yard cherry pickers, meaning yards can also use those lifting systems for other purposes.

*Figure 164 - Hull Waterblasting with Falch Robots (3000 bars 45 liters)*

### 4) Spot Repairs & Unreachable Areas Blasting – (~SA2 – 3000 bars) – Multiworker – Lift Worker

Minor repairs like fenders, fishing plate areas, and keel block areas must be blasted with manual systems. But as engineering, manual systems can also be improved with proper tools. As a Falch, you can make that area without problems with the tools below. The efficiency of multi-worker systems (3000 bars 22 liters) can be 12 m2/h, which is double manual gun usage, and it will be constant because it is not related to the workers' performance.

*Figure 165 - Hull Spot Repairs With Multiworker*

### (b) Underwater Systems, (Boottop – Vertical Side – Flat Bottom Coating)

Antifouling coatings are used widely to protect the vessels from fouling and to save some fuel due to the impact of hull resistance on the hull condition. This fouling can increase fuel consumption by 20 – 40 % to reach the same speed from a new building and after dirt condition.

*Figure 166 - Laid Up of Ships (Mediterranean Sea - 6 Months)*

Different antifouling systems can be used in some vessels (containers, RORO, tankers, etc.) where speed is so essential. However, in some cases (offshore platforms, barges, fishing boats, etc.), there can be so much waiting in anchorage, and after some non-working conditions, antifouling performance is not so important. None of the manufacturers gives any warranty about that situation.

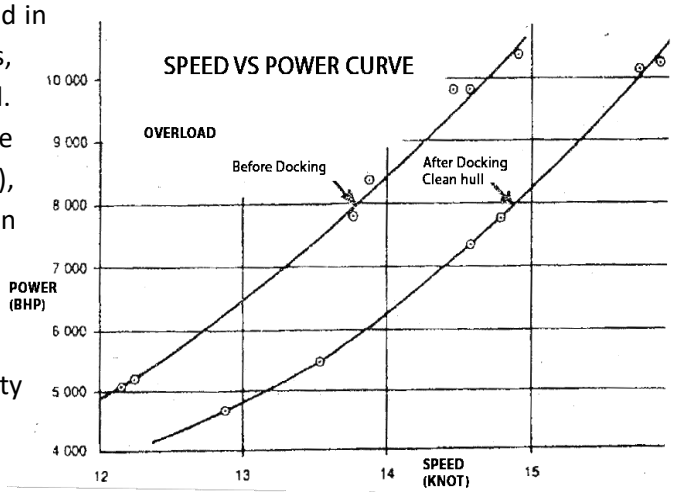



*Figure 167 - Speed & Power Curve for Ships Depends on Hull Cleaning*

Due to vessel requirements, antifouling is so important sometimes, but primer and barrier coat are more critical than antifouling. Zinc barrier coats or arctic vessels (where fouling activities are not so much) need more impact properties than fouling properties.

The vessel needs antifouling certificates to show the port authorities according to IMO Conventions (The International Convention on the Control of Harmful Anti-fouling Systems on Ships). Nowadays, the efficiency of antifouling is so essential and, according to Low Sulphur Fuel Consumption, saves the environment. In 2020, there can be new standards for antifouling quality with a solid link to ballast water treatment rules and SOx – NOx regulations.

All antifouling products must have **a TBT-free** certificate with an approved class society.

#### *(i) Traditional antifouling systems,*

Antifouling coatings are used widely to protect the vessels from fouling and to save some fuel due to the impact of hull resistance on the hull condition. These foulings can increase fuel consumption by up to 20 – 40 % compared to reaching the same speed from a new building's clean and dirty hull conditions.

The selection of antifouling is important for vessels. The speed of the vessel, waiting times in anchorage or ports, working areas (seas), docking periods, and manufacturer references are so important for

selections. But also, the shipowner must think about the system so that during the application, the product can be applied with minimum requirements (surface preparation, overcoat time, waiting before undocking, etc.) to save time and budget. Some antifouling products can touch water after a few hours, so on the same day, the vessel can start undocking operations, but some products need 36 to 72 hours for curing. So these are extra time and cost for shipyard and shipowner.

Also, the shipowner needs to check ballast operation for undocking for antifouling applications. After the last coats of antifouling, there are some waiting times before filling tanks with ballast, so it needs to be clarified with the manufacturer in advance.

*(ii) Silicon based antifouling systems,*


*Figure 168 - Hull Coating Application for Standard Antifoulings*

Silicon-based antifouling systems are special types of antifouling for vessels. When vessels are working at high speed (more than ~14 knots of commercial ships), they try to use silicon-type products to reduce water resistance on the hull (CFD analysis on the hull can check if more information is needed) and to remove barnacles on the hull with a limited waiting time.

These coatings have so many benefits but also, of course, so many additional problems;

- Prices of the products are higher than traditional antifouling (double or more),
- Application temperature and humidity are so important (more than 10 °C etc.),
- Application thickness is so important,
- Applicators are also critical; well-known yards or subcontractors are needed,
- Masking of the hull takes some days, so additional docking days and costs,
- Roughness of the coatings is also important,
- We may need 2 – 4 manufacturer coating inspectors during the application

If any patch repairs needed, mechanical surface preparation can be an option for small patches.

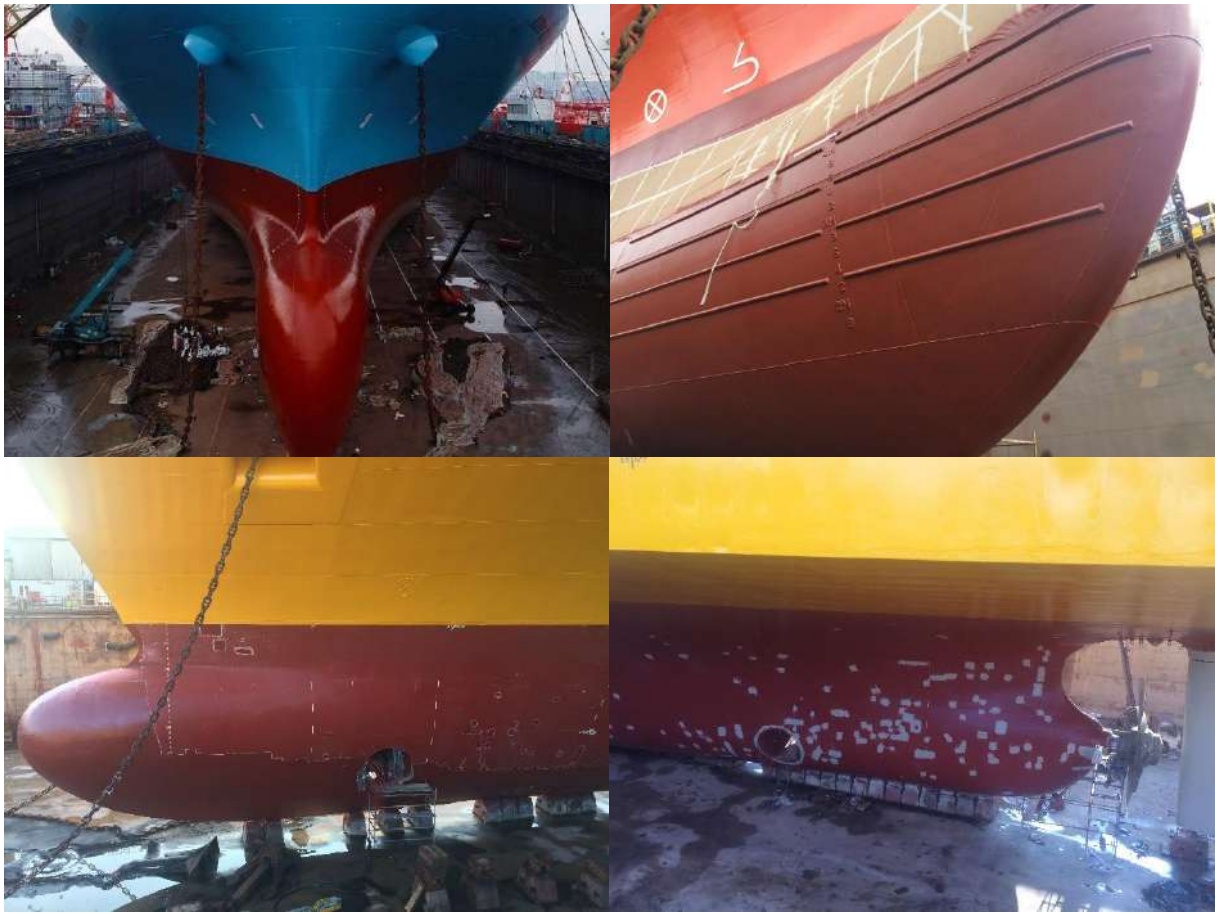


*Figure 169 - Silicon Antifouling Applications on Hull*

*(iii) MEWIS duct applications – Bulb modification – PBCF application – Ship lengthening – Propeller polishing*

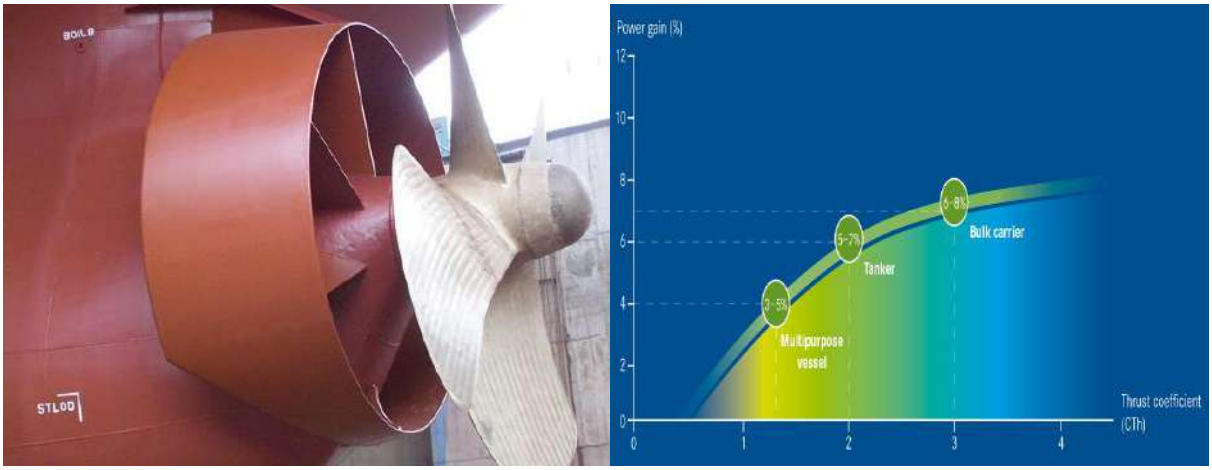



*Figure 171 - Mewis Duct Installations - (Becker Marine)*

*Figure 170 - Bulb Modification (Besiktas Shipyard)*


*Figure 172 - Ship Lengthening (Gemak Shipyard - 30 meter)*

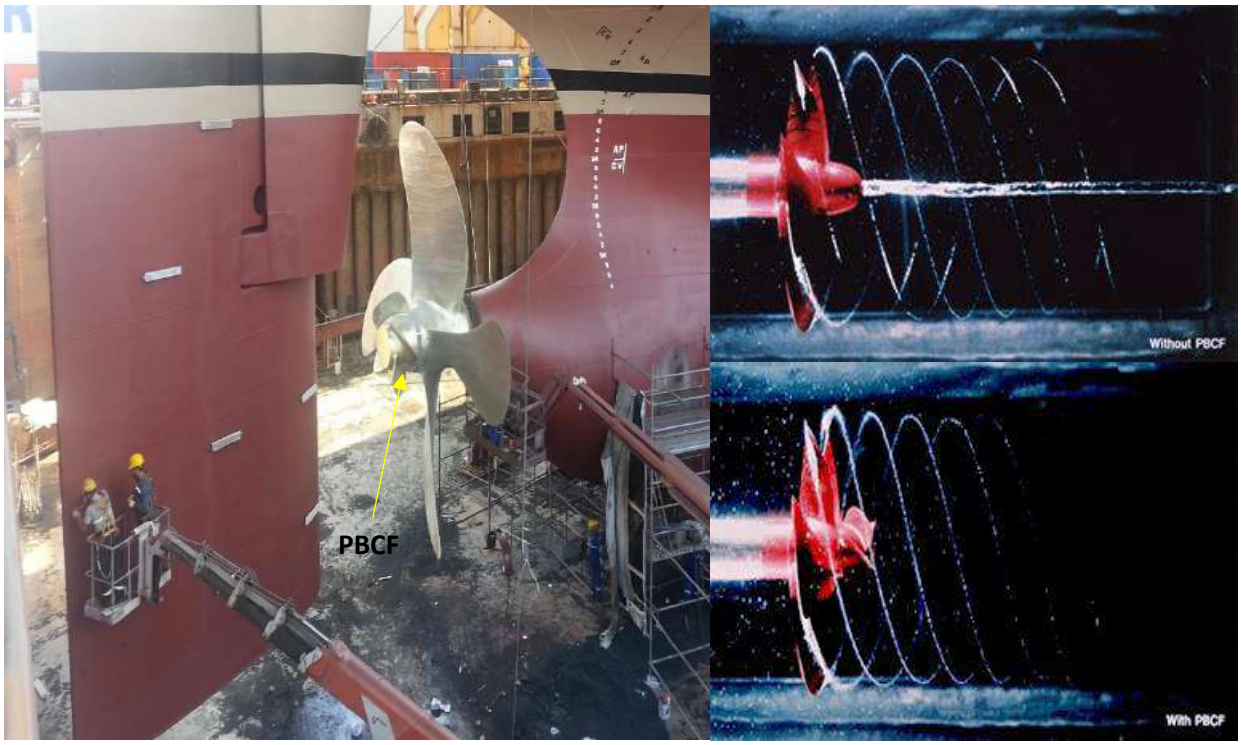



*Figure 173 - PBCF System Installation (Propeller Boss Cap Fins System)*

The above improvements are affecting the fuel oil consumption & speed by approximately 8 – 10% depending on vessel size, hull form, speed, etc. These improvements can be managed between intermediate or special surveys with some methods.

Except for silicon antifouling, coordination needs to be carried out by the ship owner and manufacturers. Installation of that system may extend the docking period, so for that reason, if prefabrications are completed in advance, this improvement would not affect docking periods. 3D scanning of the vessel's hull can take a maximum of 12 hours; for the next docking, all fleets may be ready for that kind of improvement. 3D scanning companies can prepare 3D models of the vessels, and these data can be shared with class society, shipyards, or manufacturers. Nowadays, CFD (Computational Fluid Dynamics) software is working very effectively, so naval architects can manage all installation models.

### (c) Topside systems,

Topside coating systems are essential for the vessels due to company introductions and the decorative side of the vessel. So many companies have unique colors for their topside for their entire fleet. Generally, topside coating systems are polyurethane (two components - preferred) and alkyd systems (one component), which have UV resistance for long-term color and gloss savings. In yachting industries, acrylic systems are also very famous.

Some innovative solutions like epoxy-acrylic systems can also be used for long-term (more than 20 years) UV resistance and impact effects. These systems can be used for offshore platforms, barges, coastal structures, and vessels, which do not need so many maintenance options and do not have so many port operations.

If the vessel is painted once with an alkyd system, it must be repaired with an alkyd or grid blasted fully; then, a polyurethane system can be used.


*Figure 174 - Topside Coating Application*

**Note:** Topside coating application must be completed before antifouling due to overspray effects.

### (d) MGPS systems,

MGPS systems, together with antifouling, are helpful for small vessels or yachts. With that system, sea chests and some critical locations can be saved with MGPS systems. Renewal of MGPS anodes is important, and that work can be managed immediately during the docking period. In addition, if the vessel has no spare anodes, manufacturing of the anode can be controlled by experienced companies.

### (e) Cleaning of the hull with robotic systems or divers

These hull-cleaning methods are forbidden in so many locations all over the world. Uncollected scraped barnacles and fouling can change the ecosystem of the place. As engineers, we do not suggest cleaning methods during the floating conditions. Nowadays, there are some projects for hull cleaning systems with water jetting and vacuuming of the residues combination. With a working system, this will be a good option for efficiency.

However, cleanings can be managed before departure for offshore vessels and some anchorage areas. Ecosystems are identical, and there will be no fouling transportation to other seas (Local regulations must be checked). Shipowners can use that method due to the reduction of fuel consumption. Of course, antifouling will cause massive damage after scraping works, so after some period, the vessel must enter the dock to renew its coating system.

## Section 6.03 Cargo holds coating works

Cargo hold coating works can be managed during the berthing option during the intermediate or special survey of the vessel or on ports & anchorage areas. Due to environmental effects, surface preparation of holds could not be managed with grid blasting during the floating condition. Grid blasting works can be executed during the docking period, extending the docking period to a minimum of 4 – 5 days because of limited grid blasting capacities of the yards or overlapping of the hull coating process.

The best option for surface preparation in the holds is the water jetting method, which can be useful, quicker than grid blasting, and better than other surface preparation methods (mechanical, etc.). Nowadays, coating product technology can cover all surface preparation methods with standard applications.

For cargo holds, we will compare the grid blasting method and water jetting method calculations according to time, cost, and quality.

For holds, the roughness of the surface is not so necessary; it does not affect the speed or power of


*Figure 175 - Hold Coating Application*

the engine. So, water jetting of the holds can be the best option for painting. Without grid blasting, surface preparation and paint application can be managed inside the holds. Waterblasting with robotic systems may also give owners and yards better and more speedy options.

## WATER JETTING METHOD & GRID BLASTING

## CHEMCOINT SOLUTIONS ARE COST EFFECTIVE THAN STANDARD EPOXY SYSTEMS

Below project plans and budget calculations are prepared for estimations with estimated accurate figures. Prices can change according to yard offers, but these values can be for estimations. During this time, the calculations below items are followed with experienced values and approved calculations.

**SA1 & SA2 Blasting Works;**

- Each blaster can manage ~ 60m²/shift with 1 nozzle – SA1,
- Each blaster can manage 35 m²/shift with 1 nozzle – SA2,
- Mixed blasting (SA1&SA2) accepted as 50 m²/shift with 1 nozzle.
- Total blasting capacities calculated as 24 nozzles for the yard in the dry-dock area in 1 shift.
- High-pressure water washing is required before blasting for salt or other dirt removal.
- All washing water must be collected before blasting.
- Each hold needs 2 cherry pickers for 4 blasters (no more can work simultaneously).
- Grid consumption can be calculated at ~250 tons of grit and needs to be vacuumed before coating application (~40 m² of area can blast with 1 ton of grid for SA1&SA2 ratios).**Equipment Lists:** Compressors, vacuum cleaners, grid tanks & ~500 tons of grid for usage and after completion disposal, water jets (~350 bars), paint pumps, cherry pickers for 199 shifts (Approx. 10 cherry picker for 1 shifts at the same time).

**WATERJETTING (WJ2) Works;**

- Each water jet blaster can manage ~ 150m²/shift with 1 nozzle ~ WJ2,
- Each holds need 1 cherry picker for 3 blasters (2 on basket + 1 on tanktop and man height areas).
- No grid consumption, just water disposal for water jetting.
- Total 3 water blasting machine with 6 nozzles (2 nozzles/machine) with a ~1000 bars capacities.

*Table 16 - Comparison of Chemco Systems and Traditional Epoxy Applications*

| Description | Chemcoint with Water jetting | Traditional Epoxies with Blasting | Difference |
|---|---|---|---|
| **Surface Preparation Costs** | $ 142.800,00<br>(Without any docking) | $ 307.935,00<br>(With 13 days docking) | **$ 165.135,00** |
| **Product Supply Costs** | ~ $ 1??.000,00 | **?** | **?** |
| **Total Cost Difference (Including docking periods – for Chemcoint no need but budget added)** | $ 2.. .800,00 | $ 307.935,00 **+?** | **$ ..k + Product Supply** |
| **Repair Period (Optimum resources)** | 14 days (12.5 days for Cargo Holds) With just **6 nozzles** (water jetters) without any delays for standard docking period. | 20 Days (13 days docking) with **24 nozzles blasters** | **6 days** more yard period.<br>With 60% less people. |
| **Repair Period (Minimum Duration) For Cargo Hold Works – If Required.** | 6 days for Cargo Holds With **15 nozzles** (water jetters) without docking (just in berth area.). | 13 days for **24 nozzles blasters** in drydock. | **7 days** more yard period. |
| **Minimum Hold Completion Time** | 5,5 days | 11 days | **5,5 days less** |
| **Certification** | Chemcoint System will have FDA approvals for grains etc. | **?** | **?** |
| **Rain or humidity effects** | Application can be carried out without any delay. (Except heavy rain) | Period may delay because of humidity, flush rust, rain etc. | **Rain can create tragedy.** |
| **Products** | RS 500P + RA 500M has a **glass-flake** system so can durable for impact effects | **?** | **?** |
| **Overcoat time for repairs** | Unlimited | ~ 3 months for general epoxy systems. After that surface need to be blast again for coating repairs. | **Repairs can manage due to impact effects.** |
| **Certification** | Class Approved, Grain Certified, Solvent Free | Class Approved, Grain Certified | - |
| **Loss Factor** | 30% | 30% | - |

**Equipment Lists:** Water jets (~1000 bars), paint pumps, cherry pickers for 61 shifts (Approx. 10 cherry pickers for 1 shift simultaneously).

The above table shows us that water-jetting is a better method for cargo hold coating works, which can reduce the time and budget and give the same result for long-term protection in holds. ~30 years ago, coating products could not give us that flexibility, but nowadays, tolerant epoxy products can be applied after water-jetting. However, the benefit of Chemco products is that they can also be used on wet and rusty surfaces with up to a 10-year warranty.

**Notes:**

- Blasting works are forbidden during the floating conditions in Turkey and many countries.
- Blasting works can be stopped, or the number of nozzles can be decreased during the windy weather due to environmental effects by municipality teams. (Most of the shipyard does not have a closed dock area for repair.)
- Vessel can have 4 or 5 holds, but calculations will not change according to surface preparation times or for budget.

For cost calculations, please write to faruka@efesmarine.com.tr & solution@marineindustry.net.

## Section 6.04 Ballast tank coating works

Ballast tank coating works are one of the biggest corrosion challenges in the marine industry. Generally, the ballast tanks of the vessels are mainly closed spaces, and most of the vessel team does not manage any "Planned Maintenance Systems" for the tanks. Mostly, these locations are on the Port State Control checklists and are not visible during the operations.

*Figure 176 - Ballast Tank Condition (Rust & Blisters)*

IMO MSC.215 (82) Performance Standard for Protective Coatings (PSPC) for water ballast tanks – a standard designed to achieve a target coating lifetime of 15 years in dedicated seawater ballast tanks and double side-skin spaces of bulk carriers.

All coatings must now have a "Type Approval Certificate" (TAC), which means that the product has demonstrated the expected performance, the quality of the supplied material is assured, and the supply location has met the requirements of the classification society.

Coating thickness for new building must be a minimum of 320µ DFT (Dry film thickness), and application must be carried out with a witness of Coating Inspectors.

If the tank coating condition is "Poor", it means that during the new building of the vessels, ballast tank coating thickness, surface preparations, or weather conditions are not checked properly. Washing of the tank and surface preparation on steel structure (2 mm radius on sharp edges, grinding of the welding seems, sparks, surface profiles, etc.) must be checked carefully before coating application. During the new building projects, agreed-upon repair methods can be acceptable but not advised.

The main problems inside the ballast tanks are highly corroded areas, which can create strength and water tightness problems on the steel condition of the vessel. Cracks on hull or cargo bulkheads can occur, watertight bulkheads can lose their tightness, etc. That corrosion can affect the general strength of the vessel. Remember that the chain is no stronger than its weakest link.

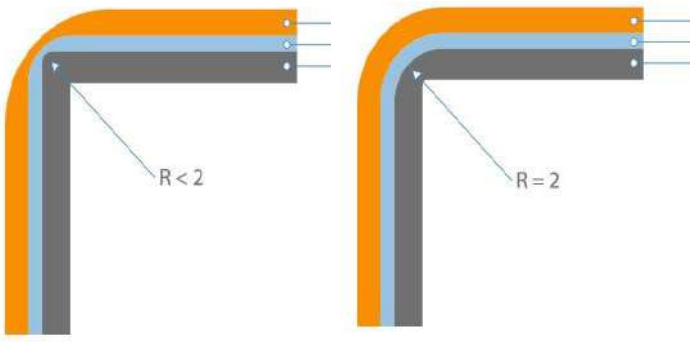



*Figure 177 - Edge Preparation for Coating Application*

The intention with maintenance and repair in the ballast tank is to either:

*Figure 178 - Waterjetted Ballast Tanks*

- Maintain GOOD coating condition, or
- Restore GOOD coating condition if the coating is found in FAIR or POOR condition.

### (a) Class survey requirements

The coating system in ballast tanks is to be examined in connection with:

- Intermediate Surveys for tankers exceeding 5 years of age,
- Special Surveys for all tankers

*Table 17 - IACS Clarification of "GOOD", "FAIR" and "POOR" Coating Conditions*

| | GOOD (3) | FAIR | POOR |
|---|---|---|---|
| Breakdown of coating or area rusted (1) | < 3% | 3 – 20 % | > 20 % |
| Area of hard rust scale (1) | - | < 10 % | ≥ 10 % |
| Local breakdown of coating or rust on edges or weld lines (2) | < 20 % | 20 – 50 % | > 50 % |
| Notes<br>**(1)** % is the percentage of the area under consideration or of the "critical structural area"<br>**(2)** % is the percentage of edges or weld lines in the area under consideration or of the "critical structural area"<br>**(3)** spot rusting i.e. rusting in spot without visible failure of coating | | | |

The coating condition in ballast tanks is assigned and categorized as GOOD, FAIR, or POOR based on visual inspection and estimated percentage of areas with coating failure and rusty surfaces.

The ballast tank will be subject to Annual Survey when, during an Intermediate or Special Survey, as applicable, it is found with:

- No protective coating from the time of construction or
- A soft coating (Banned after 2020?), or
- Substantial Corrosion or
- Protective coating in less than GOOD condition, and the protective coating is not repaired to the satisfaction of the Surveyor or
- a common plane boundary with a cargo tank with any means of heating, regardless of whether the heating system is in use and regardless of the condition of the coating.

Thickness measurements to the same extent as the previous Special Survey are mandatory requirements of Intermediate Surveys for tankers exceeding 10 years of age. However, if he considers it necessary, the Surveyor may request thickness measurements due to his examination of the ballast tanks on a tanker of any age. If the results of these thickness measurements indicate that Substantial Corrosion is present, the extent of thickness measurements will be increased.

Areas of Substantial Corrosion identified at previous Special, Intermediate, or Annual Surveys are to have thickness measurements taken at Annual Surveys regardless of the coating condition. Substantial corrosion is an extent of corrosion such that assessment of corrosion pattern indicates wastage in excess of 75% of allowable margins but within acceptable limits. When wastage exceeds the permissible limit, repair, such as renewal of the hull structural members, is to be carried out.

### (b) Repair methods for ballast tanks

The standard coating process for the steel structure (ballast tanks) is given below;

1. Mud cleaning,
2. Staging and de-staging after completion of the process,
3. Washing of the surface ~500 bars (Slime removal, salt removal, etc.),
4. Collecting the dirty water and transferring it outside (Drying the tank),
5. **Grid blasting** of the tank with abrasives,
6. Vacuum cleaning of the tank with vacuum cleaners,
7. Painting of the tank (First Coat – Touch up),
8. Stripe coat application (Welding seems, sharp edges),
9. Painting of the tank (Touch up or Full coat application).

Standard paint application for ballast tanks, cargo holds, or hulls can be managed with a listed process. But that system is a slow and expensive method. Of course, all coating companies suggest that grid blasting is the best surface preparation method; that's true but deficient. However, with an innovative and engineering solution, water jetting can also be used for surface preparation (with the support of surface-tolerant coatings). Drying and dehumidifying the tank is the most critical period for paint application inside the tanks with standard epoxies. With the water-jetting process, steps are reduced, and of course, the period of the paint application is reduced. With class-approved methods, water jetting can used as an approved surface preparation method for tanks and holds applications.

*Figure 179 - Blasting of Ballast Tanks and Coating Application (Traditional Epoxies)*

The above picture shows that blasting rusty areas is an excellent surface preparation method, but it also damages the coating, which is in good condition. If a blasting tool enters the tank, all surfaces must be cleaned with a vacuum cleaner, and additional washing is required to remove dust and dirt. Then, a minimum of 1 full coat is needed to close pinholes or grid damages.

With Chemco RS 500P – RA 500M systems, the project period can be reduced as below;

1. Mud cleaning,
2. Staging and destaging after completion of the process,
3. ~~Washing~~ Waterjetting of the surface ~800 – 1000 bars (Mud cleaning, salt removal, etc.),
4. Collecting the dirty water and transferring it outside (Drying the tank),
5. ~~Grid blasting of the tank with abrasives~~,
6. ~~Vacuum cleaning of the tank with vacuum cleaners~~,
7. Painting of the tank (First Coat – Touch up),
8. Stripe coat application (Welding seems, sharp edges),
9. Painting of the tank (Touch up or Full coat application).

Wet & rust tolerant coatings can be used for minor patch repairs or all tank coating upgrades. With Chemco RS 500P epoxy paint, all tanks can be repaired with class-approved methods and up to 10 years of manufacturer warranty without any dehumidification.

*Figure 180 - Waterjetting & Spot Coating Application for Ballast Tanks*

### *(i) Waterjetting of the Tanks*

Ballast tanks are narrow areas, and it is challenging to manage weather conditions. Dehumidification of the tanks is not easy, and for minor repairs, the costs of the dehumidification are high. Budget, time, energy consumption, and other limits can show us some innovative solutions.

Our best solution for ballast tank coating application is;

Waterjetting + Mechanical Surface Preparation (Unreachable Areas)

Painting with rust and wet-tolerant, solvent-free, class-approved epoxy paint (Chemco RS 500P)

With that system, the application time of the coating is reducing approx. 45-50% as per grid blasting application. The total budget of the paint application (Surface preparation + Paint Application + Product Supply) is also approx. 30-35% less than traditional ballast tank epoxy application systems.

**STRONG PAINT APPLICATION SUGGESTION FOR BALLAST TANKS**

All parts of the coating application (Ship-owner, shipyard, paint manufacturer) need to be fair to each other. Especially for ballast tank repair works, all parties must understand and analyze the situation, and depending on requirements, they must follow the fastest, cheapest, least workforce – equipment usage and not affect other works.

Grid blasting is not a way to do spot repairs in ballast tanks. The grid also damages strong paint, so the final coat must be applied fully. Cleaning works are increasing, and painting works will be more than actual, even in 10 – 15% spot rusty tanks.

*Table 18 - Suggested Ballast Tank Surface Preparation as Per Rust Ratio*

| **Rust Ratio (~)** | **Surface Preparation Method** | **Paint Application Method** | **Paint Specification (Coat)** |
|---|---|---|---|
| 0 – 3 % | Mechanical and Spot Washing | Brush & Roller | 2 Touch Up |
| 3 – 40 % | Waterjetting | Brush & Roller & Spray | 2 Touch Up + 1 Stripe |
| 40 – 100 % | Grid Blasting or Waterjetting | Spray + Brush | 1 Touch Up + 1 Full Coat (Min.) + 1 Stripe |
| 3 – 40 % | **Grid Blasting (Worst Case Scenario)** | Brush & Roller & Spray | 1 Touch Up + **1 Full Coat + 1 Stripe or or 2 Full Coat + 1 Stripe** |

Humans and engineers must decide that less chemical (paint – thinner – VOC, etc.) is the best selection for our life and environment. So, the most convenient way for ballast tank surface preparation is to use a water-jetting application between 500 – 1250 bars. For safety reasons, more than that, pressure is tough to manage inside the tanks if the liter of waterjet is high. If hydro blasting is essential for the location, then Falch 2000 bars – 8 liters waterjet with turbo nozzles can be the best option for surface preparation.

Hydro blasting with 1750 – 2500 bars can also be applicable for wide tanks, but selection criteria for coating repairs must be focused on protection scope. **If products require that high pressure, change the product!** There is always another solution valid for the coating problem.

During the repair period, optimization of all locations is always critical. So, for the ballast tank coating application, the owner representative and yard need to be focused on cost & and effective solutions for all parties.

*Figure 181 – Waterjetting (500 – 800 bars) of Ballast Tanks and RS 500P Application on Wet & Rusty Surfaces*

Of course, everybody would like to reach 100 % satisfied results for any work onboard. Nobody can take any risk in critical works like stern tube bearing condition, main engine bearings, and rudder or thruster problems. For coating applications, strategy is also very important. The coating must be in good order for cargo or freshwater tanks, coated fuel oil tanks, etc. Especially for chemical tanker cargo tanks, the result must be 100% satisfactory for all parties.

But for other locations like decks, bulk carriers - container vessel cargo holds, or ballast tanks, you can't follow new building standards for all repairs. Engineering focuses on total life cycle management of the product–vessel for new building plans and calculations. During the coating repair, engineers must focus on the following years of vessel and engineering solutions with an optimized budget and time.

Generally, If the coating application is carried out in good order (Focus on reaching 100% satisfaction results) during the new building, minor repairs may occur after 10 – 15 years. But especially during 2000 – 2008, new building numbers were very high, and most parties sacrificed the coating applications. So, nowadays, we have tank coating repair problems. Blasting is a time-consuming method that duplicates the budget and damages strong paint.

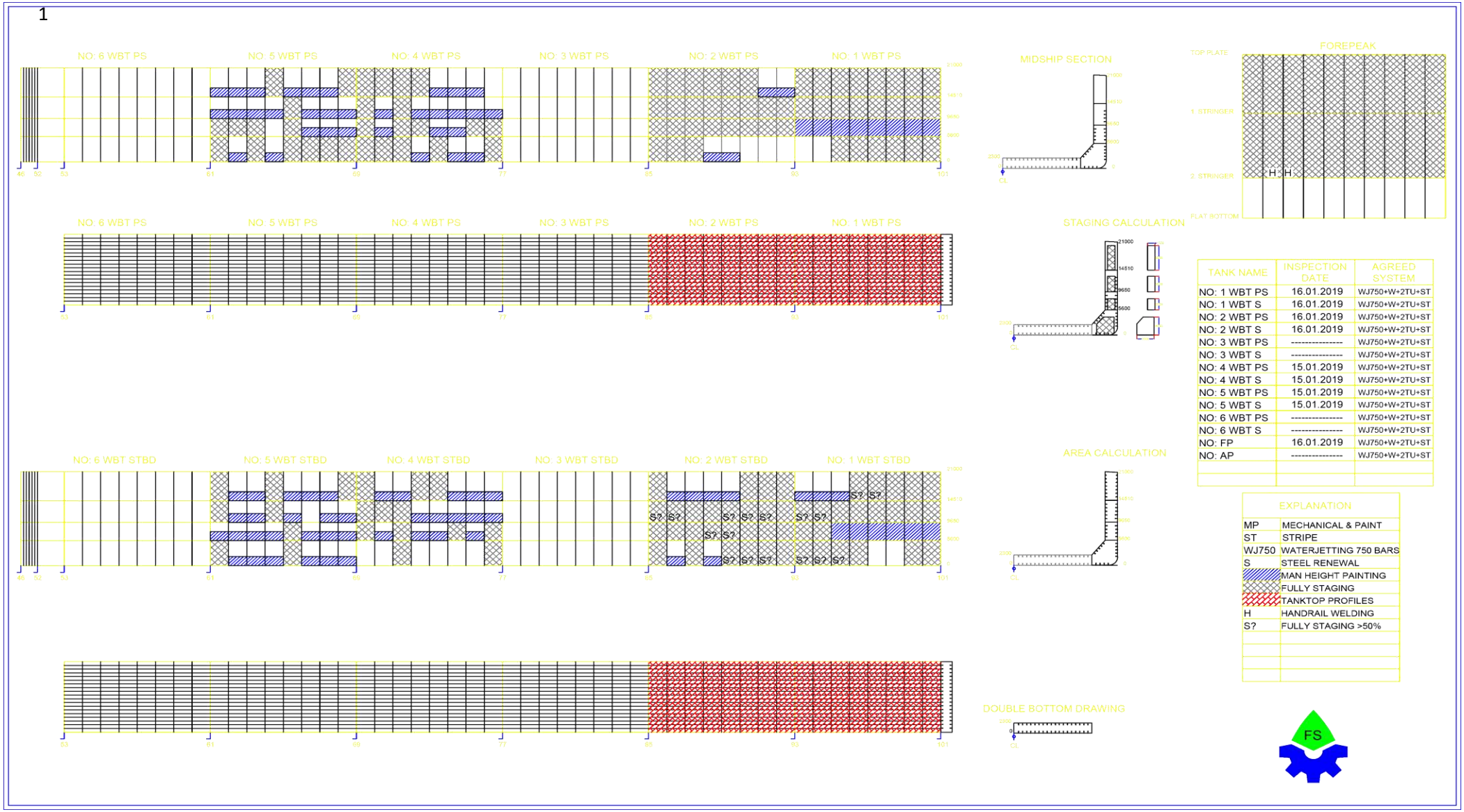
*Table 19 - Grid Blasting via Waterjetting*

| Work | Waterjetting | Blasting | Mechanical Preparation |
|---|---|---|---|
| Surface quality for coating products | Just remove existing paint and rust, no surface profile (But under the rust, there is always good surface profiles remain). | Good surface profile | Depends on tool |
| Speed | 150 – 200 m²/shift | 40 – 50 m²/shift | 3 – 5 m²/shift |
| Application budget | 10x | 25x | 5x – 75x |
| Worker requirement | Min. workforce/m² | Max. workforce for preparation | For small projects |
| | | | |

*Figure 182 - Waterjetting of Block Erection Points and RS 500P Application*

With the new building mentality, the above photo application is unacceptable. However, on repair projects and engineering methodology, the above system will work more than 90 – 95 % for the next five years, and the ship-owner will have another option for the following years. Delays can create some +100k thousands of dollars for perfection.

Especially for CAP surveys, coating system decisions, calculation of steel and staging works, docking works, and planning the entire project with design, project planning team, and experts are critical.




| TANK NAME | INSPECTION DATE | AGREED SYSTEM |
|---|---|---|
| NO: 1 WBT PS | 16.01.2019 | WJ750+W+2TU+ST |
| NO: 1 WBT S | 16.01.2019 | WJ750+W+2TU+ST |
| NO: 2 WBT PS | 16.01.2019 | WJ750+W+2TU+ST |
| NO: 2 WBT S | 16.01.2019 | WJ750+W+2TU+ST |
| NO: 3 WBT PS | ---------- | WJ750+W+2TU+ST |
| NO: 3 WBT S | ---------- | WJ750+W+2TU+ST |
| NO: 4 WBT PS | 15.01.2019 | WJ750+W+2TU+ST |
| NO: 4 WBT S | 15.01.2019 | WJ750+W+2TU+ST |
| NO: 5 WBT PS | 15.01.2019 | WJ750+W+2TU+ST |
| NO: 5 WBT S | 15.01.2019 | WJ750+W+2TU+ST |
| NO: 6 WBT PS | ---------- | WJ750+W+2TU+ST |
| NO: 6 WBT S | ---------- | WJ750+W+2TU+ST |
| NO: FP | 16.01.2019 | WJ750+W+2TU+ST |
| NO: AP | ---------- | WJ750+W+2TU+ST |

| EXPLANATION | |
|---|---|
| MP | MECHANICAL & PAINT |
| ST | STRIPE |
| WJ750 | WATERJETTING 750 BARS |
| S | STEEL RENEWAL |
| | MAN HEIGHT PAINTING |
| | FULLY STAGING |
| | TANKTOP PROFILES |
| H | HANDRAIL WELDING |
| S? | FULLY STAGING >50% |

*Figure 183 - Summary of Ballast Tank Inspections For Shipyard Repairs*

Before arrival to the shipyard, if tank inspections are completed in advance (For budget and yard quotations ~3 months, equipment, and project plan ~15 days in advance) with class surveyor or inspectors, then the shipyard can immediately start staging works. Initially, they can prepare their workers and equipment.

After vessel arrival, teams and equipment can be onboard, and work starts immediately. Works can proceed without waiting for standard inspections. During the class surveyor inspection, if they request additional areas, then these extensions can be managed by the yard team immediately.

Working with experts for segregated works (steelworks for mid–to big-sized projects, coating experts, ship repair experts) will be the most efficient and generally cost-effective way for ship owner companies. Especially if the experts are working the same kind of work so much with different locations, they will have a chance to see other short paths without sacrificing quality.

*Table 20 - Surface Preparation and Coating Application Schedule Estimations (For Turkish Shipyards)*

| **Vessel Sizes (Tankers – DWT)** | **Grit Blasting (~)** | **Waterjetting (~)** | **Waterjetting & Painting With Chemco (~)** |
|---|---|---|---|
| Up to 50.000 | 35 days | 30 days | 20 days |
| 50.000 – 120.000 | ~45 days | 35 days | 25 days |
| 120.000 – 200.000 | ~50 days | 40 days | 30 days |
| Above 200.000 | >~50 days | 45 days | 35 days |

The above estimations are given for 5 – 40 % rusty surfaces for ballast tank estimations. Coating experts must manage calculations and must be checked with yards. Shipowners must be careful; yard marketing departments are not experts (mid-sized yards); they are just roughly giving the dates. Staging works and locations can extend the scopes for both application methods.

The above calculations include staging works, cleaning and painting periods, and filling the tank with ballast. Also, minor steel works can be completed during the coating process in the Chemco coating application method (Up to ~2-ton steel/tank). Due to construction or docking arrangements, there may be ~3 – 5 days' difference.

Recommended short term maintenance

| Target Lifetime | Areas under consideration evaluated to | Pre-treatment[1],[2] | Coating system | Dry Film Thickness (DFT) |
|---|---|---|---|---|
| **Short term maintenance (5 years)** | GOOD | • Removal of mud, oil, grease, etc.<br>• Fresh-water hosing<br>• Drying<br>• Power tool cleaning/ wire brushing<br>• Climatic control | "Hard coating" compatible with original coating or equivalent.<br><br>Recommended "hard coatings" are<br>• Pure or modified epoxy<br>• Solvent less epoxy<br>• Solvent free epoxy[3]<br>• Epoxy mastic or surface tolerant | • 1 diluted touch-up/stripe coat<br>• 1 x 100 µm 1st coat |
| | FAIR | • Removal of mud, oil, grease, etc.<br>• Fresh-water hosing<br>• Surface treatment of damaged area by blast cleaning to grade Sa 2[4] or equivalent[5]<br>• Drying<br>• Climatic control | | • 1 diluted touch-up/stripe coat<br>• 1 x 100 µm diluted 1st coat[6]<br>• 1 x 100 µm 2nd coat<br>• DFT correction |
| | POOR | • Removal of mud, oil, grease, etc.<br>• Fresh-water hosing<br>• Surface treatment of **all** areas under consideration to grade Sa 2[4] or equivalent[5]<br>• Drying<br>• Climatic control | | |

Recommended medium and long term maintenance

| Target Lifetime | Areas under consideration evaluated to | Pre-treatment[7] | Coating system | Dry Film Thickness (DFT) |
|---|---|---|---|---|
| **Medium term maintenance (10 years) & Long term maintenance (15 years)** | GOOD | • Removal of mud, oil, grease, etc.<br>• Fresh-water hosing<br>• Drying<br>• Power tool cleaning/ wire brushing<br>• Climatic control | "Hard coating" compatible with original coating or equivalent,<br><br>Recommended "hard coatings" are<br>• Pure or modified epoxy<br>• Solvent less epoxy<br>• Solvent free epoxy[8]<br>• Epoxy mastic or surface tolerant | • 1 diluted touch-up/stripe coat<br>• 1 x 100 µm 1st coat |
| | FAIR | • Removal of mud, oil, grease, etc.<br>• Fresh-water hosing<br>• Surface treatment of damaged area by blast cleaning to grade Sa 2½[9]<br>• Drying<br>• Climatic control | | **Medium term maintenance:**<br>• 1 diluted touch-up/stripe coat<br>• 1 x 150 µm diluted 1st coat[10]<br>• 1 diluted 2nd stripe coat<br>• 1 x 150 µm 2nd coat<br>• Dry Film Thickness (DFT) correction<br><br>**Long term maintenance:**<br>• 1 diluted touch-up/stripe coat<br>• 1 x 150 µm diluted 1st coat[10]<br>• 1 diluted 2nd stripe coat<br>• 1 x 100 µm 2nd coat<br>• 1 diluted 3rd stripe coat<br>• 1 x 100 µm 3rd coat<br>• DFT correction |
| | POOR | • Removal of mud, oil, grease, etc.<br>• Fresh-water hosing<br>• Blast cleaning of **all** areas under consideration to grade Sa 2½[9]<br>• Drying<br>• Climatic control | | |

*Figure 184 - Ballast Tank Maintenance Systems with Standard Epoxies as Per IACS Recommendations*

## Section 6.05 Chemical Tank Coating Works

Chemical tanker's cargo tank coating works are one of the most challenging application processes for shipyards, coating manufacturers, and ship-owners. According to applications, most products can be applied with special surface preparations and weather conditions (Heating tank up to 80°C., etc.)

During the coating selections, there are two options. One of them is using the same system with the existing coating or the new systems with a good repair reference.

The listed items are essential for aggressive chemicals for standard tank coating applications.

- Surface profiles (SA2 ½),
- Humidity (Depending on the product, can be less than 50%),
- Temperature (During the initial curing process, some products need around 80°C),
- Application thickness (During the application, if the thickness is less, products can weaken and not work correctly, but if the thickness is more, it also creates a problem with flexibility and cracks.

*Figure 185 - Cargo Tank Coating Repairs*

On the other hand, not all tankers carry the most aggressive chemicals in their cargo, so optimization of the vessel needs to be planned by the ship owner. There are some proven solutions for touch-up repairs without grid blasting. Significant tank coating improvements can be completed with water jetting, too. Even well-known cargo tank coating (Marineline repairs with Chemco Systems, etc.) repairs can be achieved without blasting.

Below tanks are waterjetted with 1000 – 1250 bars range after cleaning 3 coat epoxy system applied. Depends on carried chemicals, waterjetting – waterblasting can be option for surface preparation.

*Figure 186 - Chemical Tanker Cargo Tank With Waterjetting (RS 500P + R 500M)*

## Section 6.06 Crude Oil Tank Coating Works

In addition to the IMO MSC.215 (82) Performance Standard for Protective Coatings for water ballast tanks, crude oil tanker owners face a new set of SOLAS regulations, approved by the IMO at MSC87 in May 2010, which are designed to ensure the longevity of cargo oil tanks.

The IMO MSC.291(87) Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers is a standard designed to achieve a target coating lifetime of 15 years in cargo oil tanks of newly constructed crude oil tankers greater than 5,000dwt where

- The building contract is placed on or after 1 January 2013 or, in the absence of a building contract,
- The keels that are laid or which are at a similar stage of construction on or after 1 January 2014,
- Or the delivery of which is on or after 1 January 2016.

All coatings used within the cargo oil tanks must comply with PSPC regulations effective from 1 January 2013 – tank coatings must have a 'Type Approval Certificate'. As we see that all the dates are passed so we can all vessels from today.

The crude oil tank can be painted with proper products with grid blasting, which can be a tragedy. We suggest managing that application without grid blasting. For grid blasting, all tanks must be washed with chemicals to protect against grid/dust materials sticking on the surface, which may affect the following cargoes.

## Section 6.07 Fresh Water Tank Coating

Freshwater tanks are an essential storage point for vessel teams, and the quality of potable/drinking water can affect the health and efficiency of the crew. If any damage happens to the coating system of the tank, the ship crew has no chance of repairing it with standard epoxy coatings (Solvent-free epoxies needed). The surface must be SA 2½ for traditional solvent-free epoxy systems, and dehumidification procedures must be followed, which requires additional tools. In addition to that item, complete curing can take 5 – 7 days (20 °C), affecting the water consumption and supply process. Even in the yard repair period, grid blasting and painting of the tank can cost the yard and ship owner 5 – 10 days, which is a critical time and 10k+ budgets even for minor repairs. And products need to be solvent-free + NFS or FDA approval for food contact.

*Figure 187 - Fresh Water Tank from Newbuilding*

The crew can make minor repairs after fresh water washing or mechanical surface preparation with Chemco RS 500P + RA 500M solvent-free epoxy systems. The system will have FDA and NSF approval, and in addition to that, in 24 - 72 hours, they will have a chance to use the tank again. Less than 1k USD budgets that operation can manage easily. The yard can proceed with other works; with the minimum workforce, they will have a chance to complete the scope. Shipowners can pay less and stay safe with approvals and high-tech corrosion protection.

*Figure 188 - Fresh Water Tank Patch Repairs (RS 500P + RA 500M Solvent Free Epoxy)*

## Section 6.08 Special Type of Coating Applications

### (a) Hot location coating systems,

In the vessel, some locations can reach up to 500 °C, and corrosion can start immediately if the coating of the place failed before. During vessel operations, failed areas can create a problem, and all operations can be stopped.

Hotcote systems can be used for that kind of problem up to 900°C. Without any breaks, these systems can be used onboard.

Also, steam lines in the main deck are another challenging area for tankers and crude oil vessels. These rusty areas are mainly galvanized, so many coating systems fail in those locations. In addition, a particular type of corrosion mechanism works in that area (Corrosion Under the Insulation – CUI). The best option for Steam Lines or heated lines will be the RL 500PF application on those lines. It has up to 150 °C heat resistance, and due to its special resins, the product can stick on top of galvanized, blasted, or waterjet-applied surfaces.

*Figure 189 - Steam Line Corrosion (CUI) and Coating Application (RL 500PF)*

### (b) Anti-skid coating systems

Antiskid coating systems can be used as deck coating systems for all kinds of vessels for walkways. There are several ways to prepare the antiskid coating application, but using some grid materials and epoxy systems is the easiest way. The primary coating system can be done with a 3 – 4 coat process.

*Figure 190 - Antiskid Coating Application*

1. The coat can be applied as a primer coat after the surface treatment of the steel.
2. The coat can be applied with skid material as a chicken feeding method. During the spray paint application, one crew can manage sand (grid) surfacing method on wet paint.
3. The final coat can be applied after vacuum cleaning the non-stick grids, and then the final coat can be used to protect the grid materials.

## Section 6.09 Cathodic Protection

### (a) Anodes,

The hull cathodic protection problem can be solved in several ways. The most known ways are welding or fixing zinc (or) aluminum anodes to the hull, impressed current cathodic protection (ICCP) systems, or high zinc concentrate hull epoxy primer systems.

With sacrificial anode protection systems, Al and zinc anodes are widely used. Due to the cadmium content of zinc anodes, to protect the environment, cadmium will soon be forbidden due to its effects on marine growth and human beings. Another benefit of Al anodes is their electrical capacity in seawater (2.800 Ah/kg), which is better than Zn anodes (780 Ah/kg). So, with that electrical capacity, an Al anode's lifetime is more extended than a Zn anode's.

Calculating the amount of anodes can be done in two ways. Wet surface area, salt content of the water, vessel activities, or tank constructions also change that amount. During the new building stage, yards and design departments prepare the anode plans for dockings, including anode welding or fitting plans.

**All anodes need to be zinc-type for chemical tankers due to spark effects.**


*Figure 191 - Anode Protection for Ballast Tanks*

### (b) ICCP systems (Impressed Current Cathodic Protection),

ICCP systems are well-known cathodic protection systems for hull protection on vessels. Generally, the system works with control panels in the engine room (for the aft side) and the forecastle area (Void space, etc. – forward side) hull anodes with reference cells. The system works with a DC current to protect the hull from corrosion. With that system, bow thruster tunnels or sea chest areas could not protected because of electric current ways.

*Figure 192 - ICCP Usage for Hull*

During the installation of the ICCP system, cell and anode cofferdams leak tests must be carried out correctly. Those parts are directly welded to the hull side, so NDT tests and proper coating application on that location are also necessary.

In the way of the ICCP anode's location, there must be insulated locations with light epoxy fillers to protect and work the system properly. During the hull blasting, that area must be grid blasted (SA2 – SA2½) because of the filler surface preparations. Also, solvent-free RS500P + RA500M can be applied with a spray of around 1500 microns or more (~4 coats), depending on manufacturer instructions. In that way, paint has more abrasion force if compared with fillers, so with a Chemco system, the dielectric shield layer will be stronger.

If the ICCP system fails during the sailing, repair must be done immediately. The vessel can sail without the ICCP system, and one year later, 30 – 50 % of hull steel can change due to a huge pitting problem. According to the picture, the pitting depths are approx. 15mm and costs the owner a 1-month extra docking period, steel renewals (150 – 200 tons), and more.

# Article VII. ENGINE ROOM WORKS

Overhauling of the main engine is mainly managed by technical teams (engine crew, yard, sub-contractor) with the support of the ship crew and manufacturer manuals and technical teams. At the beginning of the overhaul, the ship crew can explain the main problems in the engine. Also, class surveyor requests are preparing the work scope for the engine works for the yard.

Depending on the survey content, performance values must be checked by the vessel team.

Generally, depending on engine type and vessel age, bearing inspections, deflection controls, and piston overhauls can be done as per manufacturer instructions. The best solution is to follow the manufacturer's instructions.

A clean engine room means a headache-free overhaul or repair period. All openings, like skylights, must be closed during the blasting or other works. Also, engine/pump room bilges must be cleaned and painted before departure from the shipyard. During the port state inspections, those areas are also critical. Painting the bilge area (oily surfaces) is one of the most complex onboard processes. RL 500PF Oil Tolerant epoxy can be used as a primer coating for those locations.

**Engine room and bridge are the safest areas for shipowners. In that location, several people graduated from universities and spent 24 hours on duty during the vessel's life cycle.**

*Figure 193 - Main Engine Overview*

## Section 7.01 Engine Overhauls

Cylinder heads, pistons, cylinder liners, crank pin bearings, main bearings, injectors, or fuel pump cleaning and overhauls can follow up with working hours. If there is no problem on ME, the ship crew can check and record the running hours and follow up on the planned maintenance system.

In addition to standard overhauls, there can be some different repair methods. For corrosion on piston crowns, jackets, etc., there may be the option to make epoxy repairs, laser cladding, or more to use

existing parts without any future problems. Before any hot work or repair, inspection of the parts must be controlled as per manual or manufacturer instructions. Grove fillings or machining must be carried out as per clearance values.

After the opening, any ME-related parts must be carefully protected from dust, particles, etc. During the bearing inspections or other parts, the crew must carefully clean the location and check with supervisors if any broken parts are discovered. Minor investigations must be conducted in situ to solve the problems.

*Figure 195 - Main Engine Protection and Piston Crown Repairs*

## Section 7.02 Pump Overhauls

Generally, the vessels must give orders for genuine spares for pump overhauls before the ship arrives at the shipyard.

### (a) Ballast pump overhauls

Ballast pump overhauls are critical for docking operations and repair periods. Generally, at least two ballast pumps are in the pump or engine room. Again, depending on the vessel repair period, pumps can be overhauled step by step to maintain vessel ballasting operation ability. During the docking or undocking, a minimum of one of the ballast pumps must be in working condition. So, in the worst condition, one overhaul can start after the vessel's arrival, and the yard must fix the overhauled pump before the undocking operation.

### (b) Cargo pumps overhauls

Depending on sizes and working principles, the yard and owner must check spares and removal requirements (i.e., Framo-type pumps need high crane operations to remove from the tank). Before arrival at the shipyard, vessel drafts, length of Framo & Shinko Pumps, etc., will be critical and must be agreed upon by the yard and ship owner.

For deep well pumps, critical items are the cofferdam pipes' length, yard crane availability, and height above the main deck level. If the repairs are just in situ and easy to manage, but if the pumps must be removed together with the pipe, then precautions and the berthing condition of the vessels are also critical. All manuals and operation plans must be discussed with a shipyard in advance.

Standard cargo pumps in pump rooms can be removed after vessel arrival, and immediate work can start with spares. If any repair is needed, it depends on yard capacity and can fixed with some mechanical touches. The vessel and yard team must be careful during the removal and fitting back process. If any leaks occur during the removal or installation, all bilge must be clean for safety issues, explosions, etc.

*Figure 196 - Cargo Pump Bellmouth Suction*

About deep well pumps, under the bell mouth section may have some pitting. Pitting repairs can be managed with RS 500P + RA 500M glassflake epoxy.

## Section 7.03 Electric motor overhauls

Electrical motor overhauling is one of the standard work for yards. Most of them are using subcontractor workshops for overhauling. Critical items for electrical motors are;

1. Insulation of windings – varnish application – heat curing process,
2. Bearing condition and selection of trustful maker product,

3. Shaft and case wear down and repair methods (Spray welding, machining, etc.)
4. Dynamic & Static balance of impellers,
5. Vibration checks and optical alignment – if needed.

Most electrical motor overhauls can be completed in good order with the above control steps. Superintendents must follow the tests by themselves or with ship engine teams.

*Figure 197 - Electric Motor Dynamic Balancing*

## Section 7.04 Boiler Repairs

Generally boiler repairs are critical for vessel which can be managed during the docking period. Especially during the winter time, that item can be tragedy for vessel team. So if any repairs planned for boilers, it have to be coordinated with yard in advance. Cleaning must be completed for class inspections during that period.

Pipe renewals can be managed by yard without any problem. WPS and WPQR controls have to be done in advance and also materials grade are critical. In addition to that one, supply of materials can be another challenge.

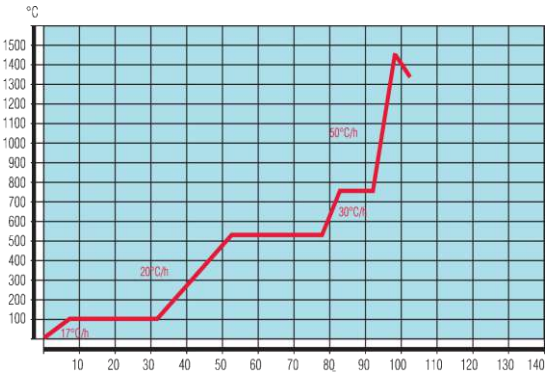



*Figure 199 - Castable Refractory Heating Graph*

Refractory application is an another topic which must be applied properly and heating process must be followed as per manufacturer suggested graph.

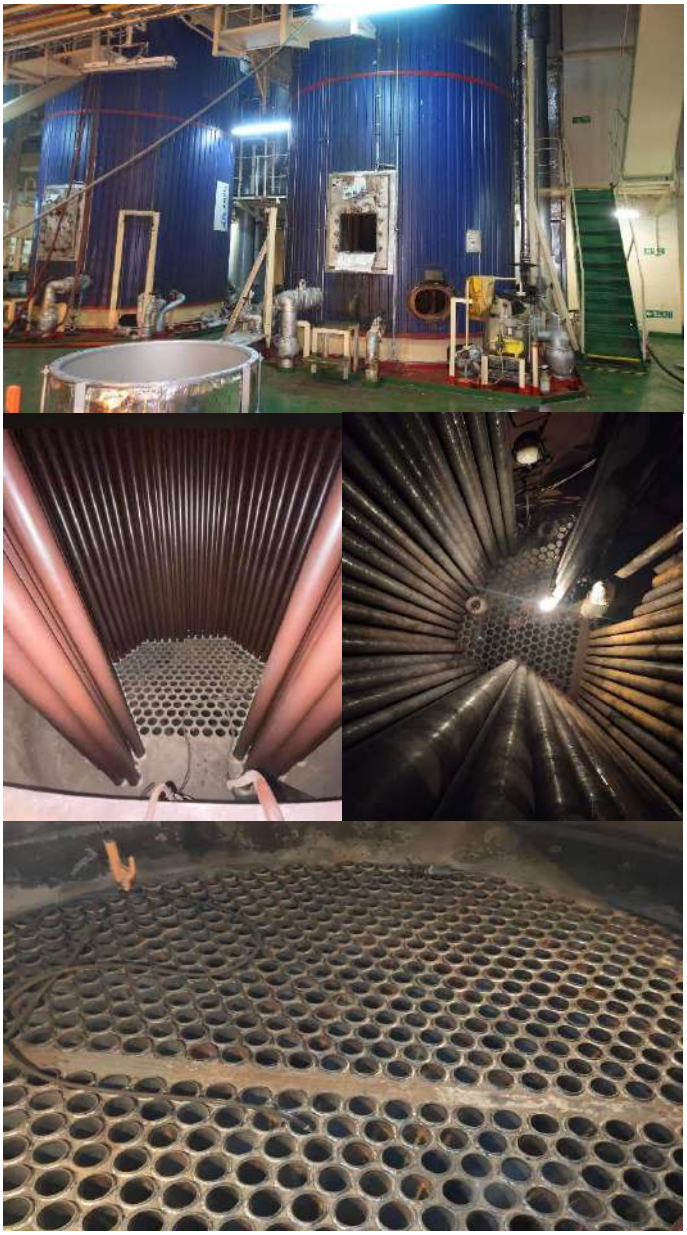
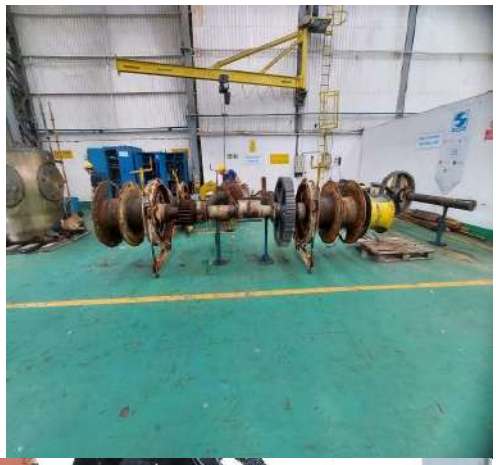


*Figure 198 - Boiler Pipe Renewal Works*

*Figure 200 - Refractory Application Process*

## Section 7.05 Windlass overhauls



Windlass overhauls are also standard items during the docking periods. Bearing or shaft repairs and brake band renewals are common but can be critical if standard precautions are not carried out during the removal of the windlass. There may also be some problems with choking compounds at the connection points.

Chocking compound breaks on foundations or asbestos contents on break bands can create huge problems later.

*Figure 201 - Windlass Overhauls*

## Section 7.06 Crane works

Cranes are critical for vessels' cargo and provision capacity. Hydraulic pistons or hoses are one of the major problems on that part, and generally, yards mechanical teams are experienced with that kind of overhaul work. Pistons may have some corrosion, but approved methods like spray welding or epoxy repairs with machining can solve most of the problems.

*Figure 202 - Crane Repairs*

Suppose the vessel has a conversion like a new crane installation. In that case, the ship-owner must be sure that the shipyard has the capacity and engineering skills for operation. Before signing the agreement, details of the operation must discussed with the yard and manufacturer of the crane.

### (a) Crane bolt fabrications

During the installation process or if any damage occurs on the bolts, the ship-owner has two options: they can try to supply from the manufacturer or fabricate a new one from the shipyard. The critical process for that part is that the supply periods are sometimes 2 – 8 weeks, but fabrication of the bolt from a local manufacturer takes around one week, including heat treatment. Strengthening the bolts with a proper heat treatment process is the critical point of the fabricated parts.

### (b) Crane tests (Load tests)

Crane tests are a class item for special surveys. In addition to that, after arrival at the shipyard, the engine room crane test is the priority for yard and ship crew operations. All crane tests can be completed after the arrival of the vessel if there is no overhaul on the equipment. In any case, the engine room crane is a priority, but other crane tests must be completed as soon as possible; if any failure happens, the owner will have a chance to fix it. During the load test, it can be managed with static and dynamic test methods depending on class requirements. Static load tests are carried out 25% above the SWL of the cranes. Dynamic load tests are related to the SWL of the cranes. Up to 20T SWL, the test load is 25% more than SWL; between 20 – 50T, the test load can be +5T of SWL; above 50T, the test load can be 10% above the SWL. Again, all test loads or procedures must be checked with class or flag state.

*Figure 203 - Load Test of Cranes*

# Article VIII. HEAT INSULATION WORKS – HVAC WORKS

## Section 8.01 Mushrooms, Air Vents and Goosenecks,

Fabrication of mushrooms and goosenecks is one part of the story, but repair and maintenance are another. During fabrication, nobody cares about the product's life cycle or corrosion protection precautions mechanisms. Generally, workshops are free from standards, especially for coating applications. They use rapid coating products, or whatever they have, so the low-quality products are incompatible with the galvanic corrosion stand. Greasing points also must be checked.

*Figure 204 - Ventilation Head & Mushrooms*

## Section 8.02 Heat Insulation in Engine Room and Accommodation Areas,

Insulation of location, compartment or accommodation areas are related with SOLAS and class rules. Critical points are fire class of the ships and location. These are affecting the thickness and certification of insulation materials. Another critical items are also application process of the insulation on the area.

*Figure 205 - Insulation for Rooms & Bulkheads*

## Section 8.03 Pipe Insulation Systems,

Steam lines or hot surfaces inside engine rooms may need insulation for crew protection, freezing, or system efficiency. These kinds of protection require different expertise and methods. The general application is to protect with rockwool materials with or without galvanized sheets. These systems generally fail on open decks and create corrosion under the insulation (CUI). RL 500 PF product can be used to stop corrosion under insulations, and the product can be used up to 150 °C even on galvanized surfaces.

*Figure 206 - Pipe Insulation Applications*

# Article IX. LIFE SAVING EQUIPMENT SYSTEMS

## Section 9.01 Lifeboat, Liferafts, Rescue Boats & Davits – Maintenance and Tests

SOLAS items are directly related to class and essential for port state controls. All labeling, coating, and parts must be free from any damage. Davits, drum coating, and general conditions are in good condition. Wire renewal works can be completed before load tests.

Coating repairs of drums are critical for vessels. Those locations generally have grease, and cleaning (blasting, water jetting, etc.) is nearly impossible for that location and costly. So, oil and surface-tolerant epoxy products (RL 500PF – Chemco International) can be a solution for the corrosion repair of those parts.


*Figure 207 – Freefall – Liferafts and Davit Load Tests*

## Section 9.02 Fire Fighting Equipment & Systems – Maintenance and Tests

The vessel team must follow the maintenance and cleaning of firefighting equipment. During the docking time, especially for special surveys, line tests can be done with the shipyard if needed. Emergency fire pump operation tests before departure are the general problematic areas for those systems. The ship crew or yard must complete that pump overhaul, and functional tests must be conducted immediately after arrival at the shipyard.

*Figure 208 - $CO_2$ and Fire Fighting Systems*

During the filling or repair of that system, additional fire extinguishers or more must be arranged by yard and to be stand by onboard. The crew must be informed by the yard of temporary equipment arrangements.

## Section 9.03 Ladders – Maintenance and Tests

Vessel teams must complete ladders or mechanical parts inspections before arrival at the shipyard. During the new building period or low maintenance practices, welding of the ladder may have some cracks, or parts may have corrosion because of wrong protection steps. The yard must follow the aluminum material welding process with class approval. During the load test, SWL is essential, and the test must be carried out with an approved methodology. Load tests must be carried out 82,5kg/person if the keel is laid up after 2010, before 75 kg/person as per SOLAS.


*Figure 209 - Load Testing of Ladders with Weight Bags*

# Article X. BRIDGE WORKS

Bridge works are another critical item that maker specialists or approved companies must follow. Yard teams can do panel removals or other outfitting works, but the ship crew can manage this work more carefully. One of the officers must always be on duty and responsible for those repairs.

Installation of systems or repairs are generally free from other vessel repairs, but critical items are supply periods of spares and team arranging on time.

For the echo sounder or speed log, the service technician may request to see the vessel's first floating condition; they would like to see inside the drydock for necessary repairs.

Also, for Gyro Compass calibrations, after completion of the repair, if the equipment has no problem before sailing, a 2 – 4 hour sea trial can be enough for all controls and calibration activities.

Again, from master to officers, that location is always occupied by trained professionals, so it is easy to follow any repair there.

# Article XI. ACCOMMODATION WORKS

The accommodation area is the area for the crew, which must have high standards for living and efficiency onboard. During the yard period, crew cabins may have some maintenance done in advance on portholes, cabin furniture, etc.

Also, during the yard period, if the boiler, galley, sewage system, or freshwater systems will have any repairs, those items must be discussed with a yard for heating, cooking, or water supply precautions to be arranged in advance. Most vessels request patience from the crew, which is hard to manage during docking when everybody is tired.

If project managers and superintendents are requesting a headache-free repair period, they must carefully focus on those kinds of personal precautions. Leaders must show their team that all members are essential.

*Figure 210 - Galley Floor Needs Epoxy Coating Repair*

## Section 11.01 Floor Renewal & Coating Works

Floor renewals are very rare works onboard; those locations must be protected before arrival to the yard. But during the yard period, if requested, floor repairs can be managed with professional companies.

The first method can follow with self-leveling solvent-free epoxy coating systems, which can solve problems in galley and baths (wet areas). These products can used with experienced yard applicators. Existing floor ceramics can be coated with epoxies, creating waterproof and clean surfaces to hospital cleaning standards.

Linoleum (or Vinyl) applications can be managed with yard subcontractors and some leveling compound applications. These applications take time (~3 – 7 days) depending on location. It has to be done individually (or group by group) for crew cabins with precautions.

*Figure 211 - Non-Skid Epoxy Coating for Accommodation*

## Section 11.02 Furniture Works

Furniture repairs can be completed during the yard period by good carpenter shops. Nowadays, furniture repair may sometimes be more expensive than supply, but, in this case, the shipowner team can follow the quotation process before the arrival of the vessel with photos and dimensions. The crew or superintendent team can check standard fabric prices with a catalog, and the decisions can be made in advance. Repair of the furniture is also helping with environmental protection.

*Figure 212 - Marine Furniture for Repair Projects*

Marine approval certificates are also important for furniture works. Shipowners and yard teams need to be focused on IMO rules (like (IMO Res.A.471 (12), IMO Res.A.563(14), IMO Res.A.652(16)), and class suggestions. Repairing existing systems is always safe for shipowners to avoid following fabrication and certification processes.

# Article XII. SPECIAL PROJECTS

## Section 12.01 Ballast Water Treatment Unit Retrofitting

We started that book in 2016, so during that period, BWTS was an erotic topic, but nowadays, we can think of it as nostalgia. I don't want to remove that scope from the book because of the system mentality.

Scrubber installation to wind-powered system installations, main engine retrofits to hull modifications (Bulb, Mewis duct, etc.) will be the same mentality and planning systems, which can be followed below.

Ballast water treatment has been the hottest challenge in the maritime industry for the last five years, and up to September 2024, it will not end. Nowadays, many shipyards have already solved that challenge with a traditional method, 3D scanning supports, etc. This regulation about BWTS already increased the standard repair periods from ~15 days to 25 - 30 days range.

Shipowners started to solve that repair period extension with innovative engineering companies and professional yard teams. Usually, these kinds of installations are new building activities for the yards, and they have enough time to build up all necessary arrangements and precautions during that process. But during the limited repair period, generally, they would like to bypass some quality and installation steps to reach the target date for departure.

The superintendent & yard must be clear about all steps of the installation manual, and it needs to be planned in good order by the yard, vessel team, and system manufacturer.

Critical items for system installations are that yards need to be more familiar with vessel lifecycle management, and they do not care about the future problems of the systems. GRE leakages because of vibrations or low-quality glue applications, etc., steel pipe corrosions due to chemical discharges or cavitation, filtering, or other equipment problems are not the critical items for repair yards.

### (a) Onboard inspections and design period

#### *(i) Onboard inspections*

These inspections can be done after clarification of the treatment system or to check available systems for your vessel or fleet. In this item, we will focus on the clarification of systems. In that item, the design company (which must have some installation experience) must be clear about the installation process and manufacturer system.

Before the design team's departure to the vessel (ports, anchorage areas in foreign countries), related engineers check the vessel drawings. According to engine room arrangements, pump room arrangements, and tank arrangements, the team is planning general BWT unit arrangements according to initial drawings. Available dimensions of the BWT unit's arrangements are planned during that inspection. 3D scanning with proper tools is also very helpful for that kind of inspection and for future decisions; without wasting any time, related departments can proceed.

After attending the vessel inspection, the team checks all the location details according to manufacturer instructions. After completion of general BWT unit arrangements, the inspection team starts to discuss with the vessel team to confirm the latest arrangements for new units and begin to measure related items and locations for class and installation drawings.

*Figure 213 - 3D Scanning for BWTS & Scrubber Projects*

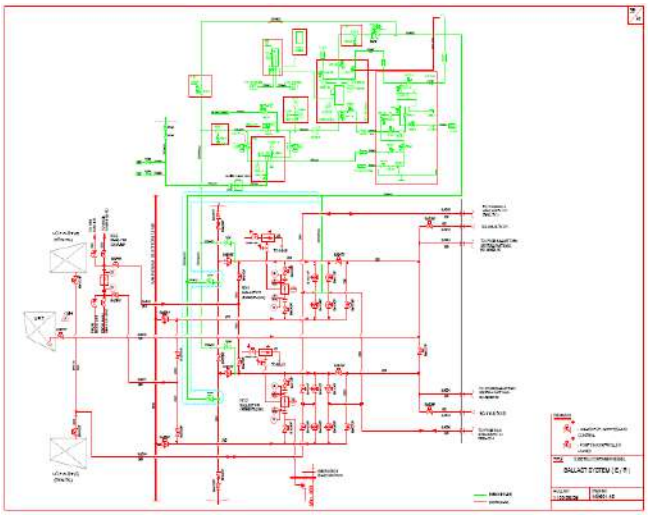


*Figure 214 - Ballast Line Diagram Update for BWTS Installation*

The inspection team can complete the initial onboard inspections between 6 hours – 24 hours (can be more for complicated systems or vessel arrangements) according to vessel sizes, equipment arrangements, and manufacturer parts. Usually, inspections can also be handled with 3D scanning systems, and it takes 8 – 36 hours. That way can also be helpful for class drawings, but it can create problems for installations because of design and inspection team mentality differences. So, the design team in the office and the scanning team must be clear about all details in advance.

With a repair design company mentality, less cabling, bulkhead penetrations, or pipe modifications can be helpful for less budget and on-time completions and practical systems.

### *(ii) Design process for class approval*

After onboard inspections, design teams prepare class approval drawings according to rules and owner requests.

Generally, a ballast diagram can be completed before the inspection of the vessel, but there may be some updates after a precise inspection.

Also, electrical drawings are important for the systems and electrical upgrades. The vessel system and location of the BWTS equipment units are important for less cabling work.

Some installations can be completed with class-approved drawings without 3D scanning or modeling of the entire system. 3D scanning is not a must. For small vessels (Like max. 150 meters with UV systems), scanning is an option, but also, if the vessel has enough time for docking or any other works (crane modifications, hold & tank steel and coating works) around three weeks, without prefabrication or 3D scanning, all system installation can be complete.

### *(iii) Design process for yard application*

The design process can start with general drawing preparations. Initially, the design (Inspection ~ same team) team can prepare 3D modeling of the BWT unit's new pipelines, out-fittings (the foundation of the units, fitting and valve arrangements, etc.), and tank modifications or fabrications for yard them to start quotation (or if agreed fabrication before vessel arrival to the yard).

*Figure 215 - BWTS Filter Foundation*

After 3D modeling of the parts and new lines, if possible, the inspection team can revisit the vessel to cross-check the dimensions and arrangements on locations if 3D scanning is not carried out. That is time-consuming activity that is not needed for experienced teams.

As an output of that, 3D modeling are.

- **Pipe modifications,**
- **Equipment arrangements,**
- **Pipe and valve part lists,**
- **Out-fitting part lists,**

The owner can manage the BWM modification process with that list, including budget calculations for yard quotations.

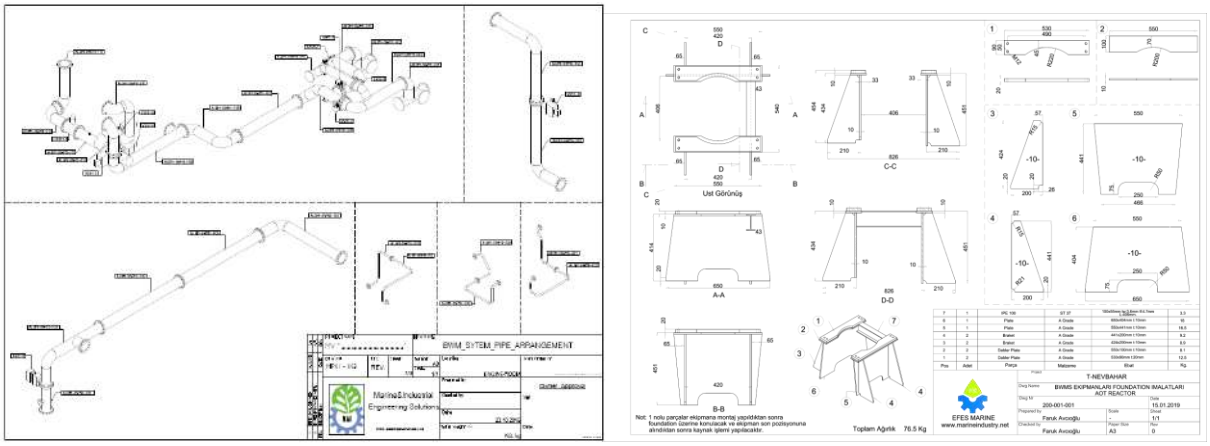


*Figure 216 - Fabrication Drawings BWTS*

### (b) Prefabrication of out-fittings and pipelines

After confirmation of the drawing's prefabrication of new lines and foundation fabrications of the BWT units can start in workshops or yards. Before the vessel arrives in the yard area, 90 – 95 % of the lines can be completed with galvanizing/epoxy coating. Foundations of the BWT units can be fabricated as per 3D models, too.

*Figure 217 - BWTS Chemical Tank Foundation and Drip Tray Under the Flanges – TK Tuzla Shipyard*

### (c) Yard installation and commissioning process

During the installation period, yard engineers and manufacturer or design company installation engineer can create strong coordination. Superintendent must be request project plan for BWTS installation period. That plan must be very detailed and including each separate foundation, equipment transfers and installations, pipe & valve installations – modifications, quality control steps, class inspections & tests and owner deliveries. Also commissioning period need to be clear with manufacturer and pre commissioning period, critical point checks need to be included in the plan. Plan can be update during the installation process but in minor way.

The yard team cannot rework for installations. The superintendent must be sure that one full system installation supervisor/engineer (from the yard) can manage that period without any problem.

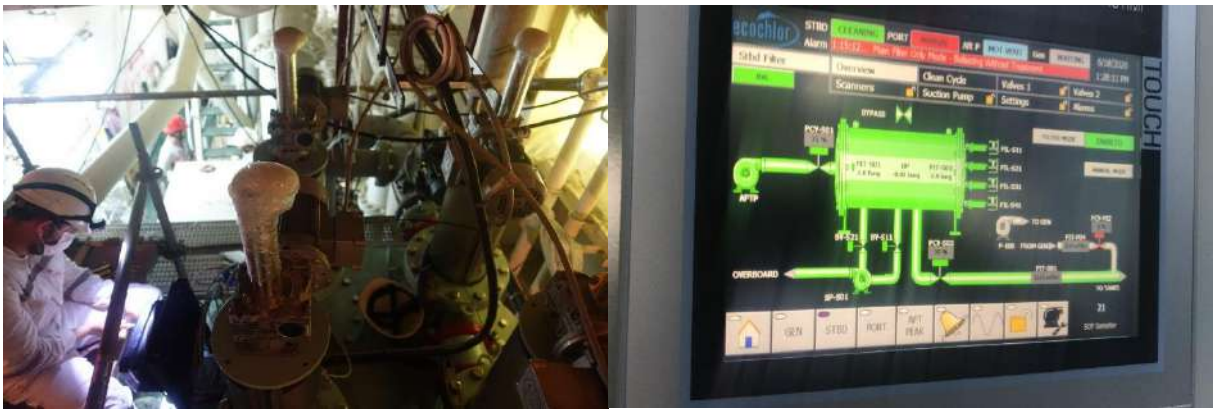



*Figure 218 - Commissioning of BWTS Parts*

### (d) Transportation of equipment's in engine room

Each unit has some heavy parts, and about the dimensions, it's not easy to transfer in the engine room. Some parts could not pass from the skylight of the vessel and may need some access from the hull or deck area. During the engine room transportation, some additional pad eye welding must be carried out by yard teams. Transportation drawings can also prepare for safe operations.

If any of the fabricated parts are damaged during the installation project, that may delay the vessel for a couple of weeks without any temporary solution.

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*Figure 219 - Damaged Filter by Yard Teams During the Transportations*

### (e) Chemical tank fabrication process

Depending on treatment methods, some manufacturer systems need additional chemical storage tanks. Typically, old vessels have no spare tanks for that kind of storage. Therefore, the yard must fabricate new tanks (deckhouse) in aft peak tanks, void spaces, on the hull side, or in special compartments on deck levels. That tank must be approved by class society. After some steel modifications, new tanks (with level gauges, fitting, etc.) must be welded and tested with pressure (air/freshwater) according to class rules.

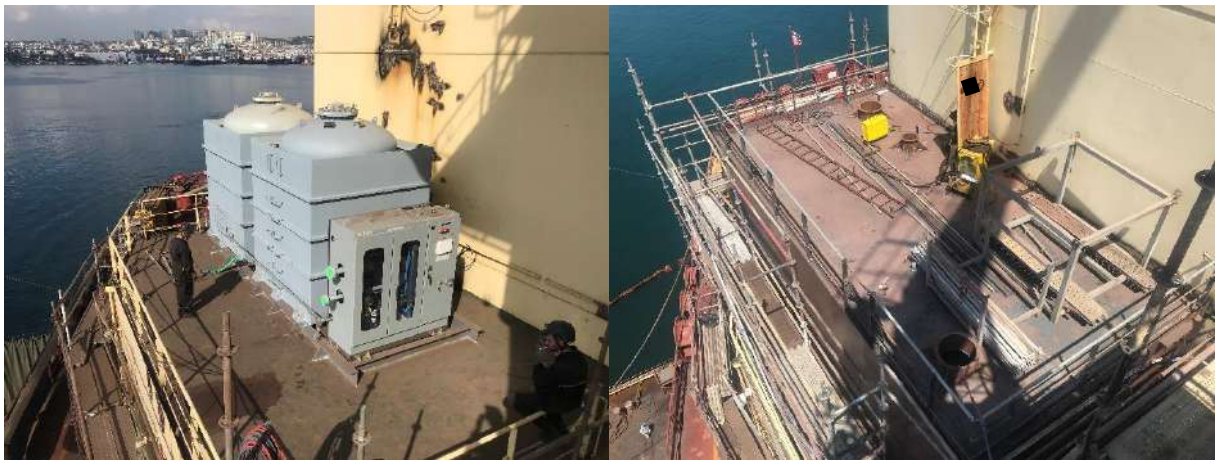

*Figure 220 - BWTS Chemical Tank and Deck House Installations*

After the new tank fabrication is completed, a suitable coating system must be carried out inside the tank depending on chemical aggressions. New line materials or coatings also must be fabricated as per chemical. New sensors, alarms, ventilation, or insulation systems must match the properties.

### (f) Outfitting works

The foundation of the units must be started after the vessel's arrival as per its location. That foundations welding (and coating works – if possible) must be completed before the equipment's transportation. Cross-checking the dimensions and bolted connection areas can be managed before and after transportation.

The strength and welding quality of the supports (outfitting parts) must be in good order as per IACS / class society rules..

*Figure 221 - Electric Panel and Filter Foundations*

## (g) Pipeline fabrications

### *(i) Workshop fabrications*

Most of the pipes can completed before docking of the vessel. For ballast line connections, the system must be free of water. Some parts have loose flanges during the prefabrication periods, and some spool parts have 50 – 300 mm extra lengths for modification misalignment problems.

After completion of welding and mechanical on pipes, there can be some galvanizing and coating process. According to that process for galvanizing works, acid cleanings can be carried out by approved galvanize companies, and 60 µ – 80 µ hot dip galvanize application can be carried out. According to the owner's request, pipes can blasted and painted.

*Figure 222 - Pipe Prefabrication for BWTS*

*Figure 223 - Prefabricated Pipe Inner Coating (RS 500P + RA 500M Glassflake Epoxy)*

### *(ii) Onboard fabrications & installations*

And some lines, like chemical dosage tank connections, must be fabricated onboard. During onboard fabrications, there can be some modifications. In addition, mainline connections and some unit connections, flange, and line connections can be installed after the workshop fabricated parts are fitted.

*Figure 224 - BWTS Line Installations*

*Figure 225 - Pressure Testing of Lines Before Commissioning*

All line pressure tests must be carried out before fixing or after completion of welding before undocking operations.

### (h) Cabling works

All cabling works (in the engine and cargo control rooms, sensor connections, etc.) must be synchronized with pipe and modification works. Connections, bulkhead penetrations, and cableways must be appropriately arranged.

*Figure 226 – Bulkhead Penetration & Cabling of BWTS Components to Electric Panel*

In the drawing system, we will also share bulkhead penetration pieces (with class-approved systems) and, if required, all cableways we can insert for the general design. Detail cabling works can be carried out during the installation. The cross-section ratio is critical for class rules, and of course, the length of the bulkhead penetration pieces is also important.

**All cables must have marine type and class approvals from the manufacturer.**

*Figure 227 - Electrical Panel Installations in Different Zones*

### (i) Commissioning

Manufacturer service engineers can handle the commissioning service. But the critical item for commissioning is the starting period of that period. If the commissioning engineer attends to the vessel's last days, it may have a chance to delay vessel departure for additional modifications or rebuilding of the parts, pipes, or cablings.

Generally, control points are pipe welding and leakage tests, cabling tests – checks, supporting equipment, sample point arrangements, etc. If, during the installation process, an experienced engineer follows all, there may be minor problems during the commissioning process.

After system delivery, the manufacturer must train the ship crew, and that training must be recorded for future crews. Training can be completed after operational test of the system by the crew.


*Figure 228 - Delivery of System with All Labeling*

After system operational tests, samples from ballast water can be checked by an approved laboratory for class or port state controls.

# Article XIII. CONCLUSION

Headache-free repair is impossible; the critical thing is which pills you use!

**Questions, comments, feedback:** faruka@efesmarine.com.tr

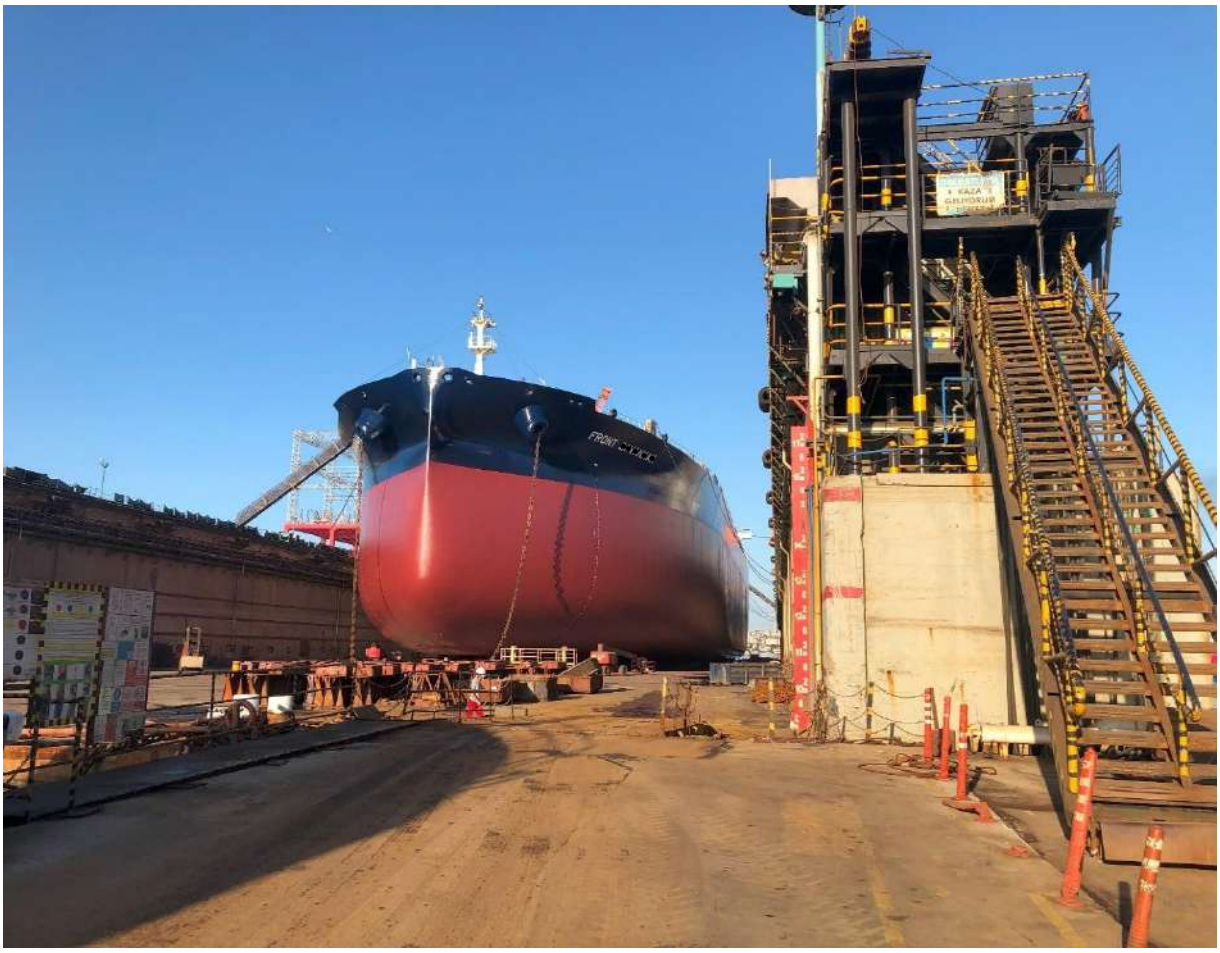

*Figure 229 - Hull Coating - TK Tuzla Shipyard*

# BALLAST TANK COATING WITH WATERJETTING

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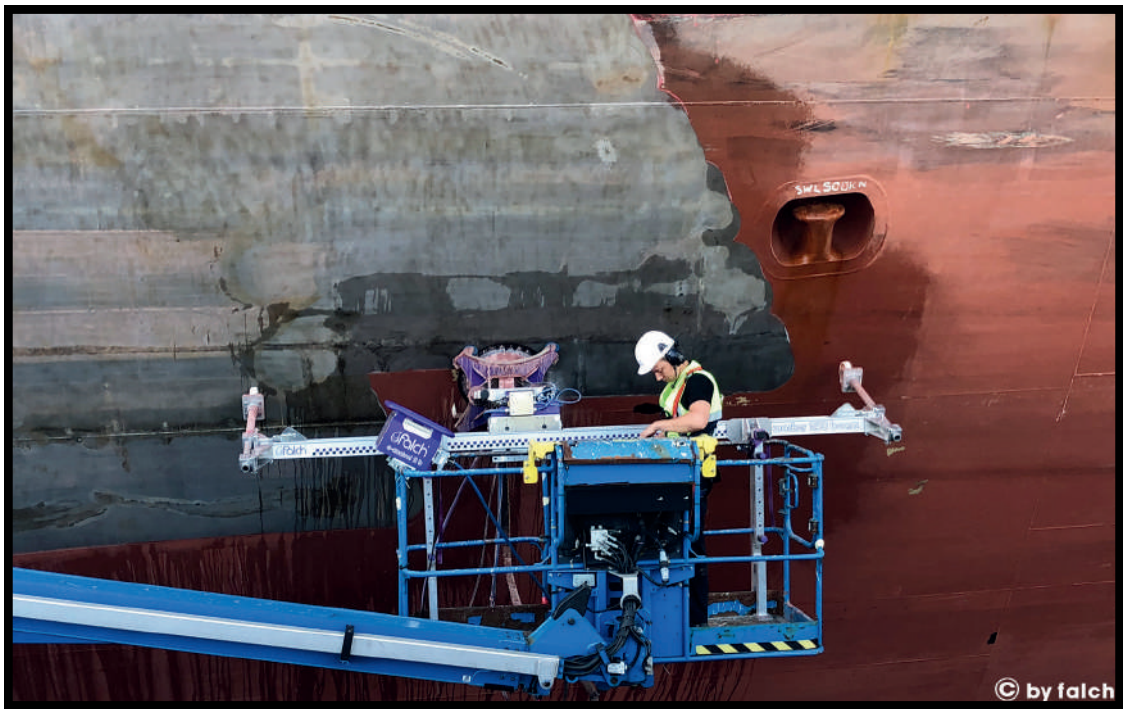



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