National Shipbuilding Research Program

EVALUATION OF NON-COPPER BASED ANTIFOULING HULL COATINGS

PROJECT RESULTS TEMPLATE
TECHNOLOGY INVESTMENT AGREEMENT #2012-453

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1.0 Executive Overview

As the presence of copper in harbor waters becomes an increasingly greater environmental concern, many jurisdictions, both nationally and internationally, are planning or already have enacted strict limits on copper effluent from port facilities and vessel operations. Studies have shown that copper-based anti-fouling (AF) paint is a major contributor to levels of copper in harbors (Figure 1), prompting the Navy to investigate alternative coating systems utilizing a non-copper-based antifouling agent. While a significant amount of testing has been done regarding the performance of non-copper-based AF coatings by the manufacturers and academia, no full scale tests involving a large Naval vessel have been performed.

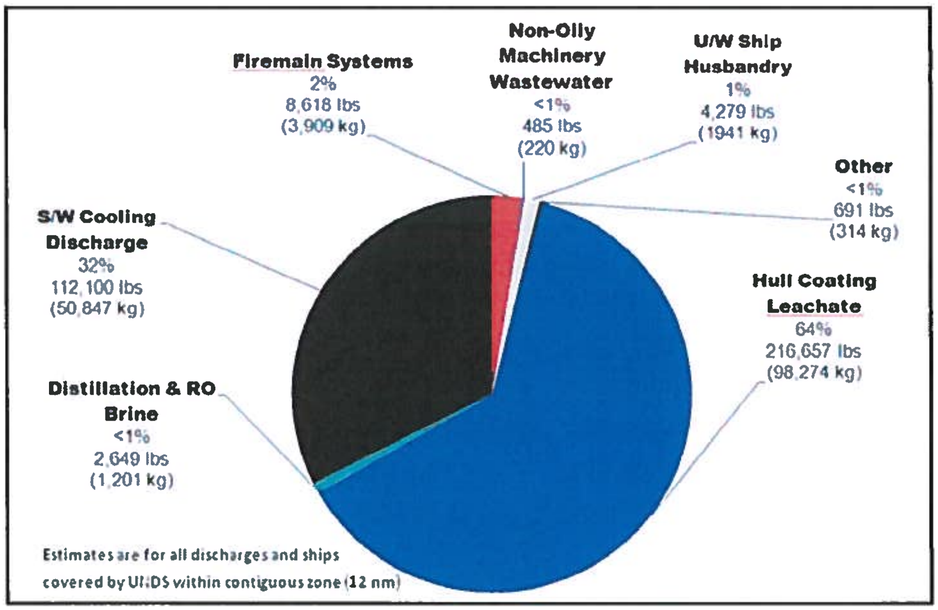

Figure 1: Total Annual Copper Loadings – Percentage by Ship Systems

Source: Phase I Uniform National Discharge Standards for Vessels of the Armed Forces Technical Development Document, EPA 821-R-99-001 April 1999

The Mobile Landing Platform (MLP) construction program underway at NASSCO in San Diego, California provided the Navy with a unique opportunity to evaluate the effectiveness of a non-copper-based AF coating system on a new vessel. Constructed under identical conditions in the same facility and launched in nearly the same environmental conditions almost a year apart, MLP 1 and MLP 2 were coated with a copper-based and non-copper-based AF coating system respectively (copper-based International Paint Interspeed 640 and non-copper-based International Paint Interspeed 5640). Water samples were collected during the float-out of the vessels from the graving dock and a comparison made to determine the actual reduction in copper concentration when employing a non-copper-based AF coating.

Analysis results from the project show that the use of non-copper-based AF paint reduces the concentration of copper in graving dock water by up to 76%, indicating that the use of a non-copper-based AF hull coating system plays a significant role in reducing copper leachate. Additionally, this study provided the Navy with a large vessel, fully employing the new non-copper based AF coating system, so that service life and maintainability questions could be evaluated.

2.0 Contact Information

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3.0 Collaborators

There were no additional collaborators on this project.

4.0 Description of Methodology

Water samples were collected during float-out at the five graving dock locations shown in Figure 2 (N1, N3, S1, S3, and Intake). The graving dock in which the ships were built provided a sampling environment that was far more controlled than the conditions that exist alongside a pier in an area subject to tidal or river flow. With a contained body of water, rather than one flowing past the ship, the changes in the copper loading of the water could be more accurately measured over time. The samples were collected at regular intervals during the float-out evolution over a 24-hour period. A two-person team was assigned to each of the four sampling stations. One of the sampling teams also collected the bay water intake samples.

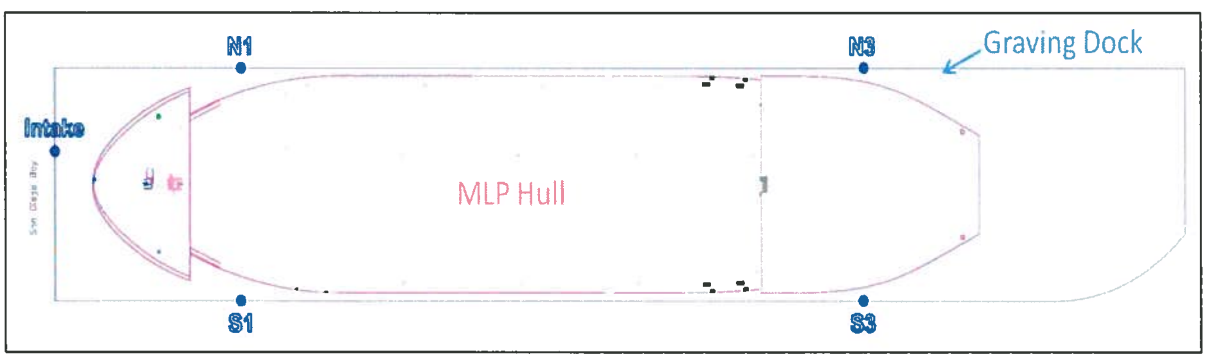

Figure 2: Graving Dock Sample Locations

The samples were collected by attaching a sterile sample bottle to a PVC pole and dipping the bottle in the graving dock water until full. Each sample was collected from approximately one foot below the flood water surface to eliminate the possibility of floating debris skewing the results. Unique sample names were created for each sample, using station location (N1, N3, S1, S3, Intake), date, and the nominal 24-hour time of the sample. Oversight and sampling activities were documented in field logbooks. Vinyl clean-room gloves were worn and discarded between sample events or if materials known or likely to be contaminated came into contact with the gloves. Samples were placed in coolers with blue ice and transported to an independent laboratory for analysis.

5.0 Resources Needed

A crew of 10 sample takers and one coordinator were assembled for the water sampling events of this project. The crew was on-call to sample at the prescribed times over the 24-hour float-out evolution (Each individual water sampling event was approximately 15 minutes in duration). An independent laboratory was used to perform the water analysis.

The sampling equipment included:

- Sterile, sealable, 1-quart sample bottles for water samples (64 samples were taken during each float-out evolution for this project)
- Large sealable plastic bags to place bottles in after sample collection
- 5 PVC poles to reach from the top of the graving dock wall to 1 foot below the floodwater's lowest surface point prior to contact with the ship hull
- Vinyl clean-room gloves, water-resistant tape to attach sample bottles to the PVC polls, and logbooks to record sample IDs and observations
- Coolers containing blue ice to hold sample bottles for transportation to the lab

As mentioned earlier, it was important that the environment in which the samples were taken be as controlled as possible to prevent contamination from outside sources. Copper concentrations can vary from fluctuations in the bay water, background levels emanating from the shipbuilding facility, and simultaneous operations in the dock or nearby. All of these influence the water samples before the ship itself is even considered. Docking methods, such as the use of a floating dock or pier-side berth, are subject to a flow of water through the facility, making it difficult (if not impossible) to measure the amount of copper that is being added to the water during the launching operation. The principal controls in this project, therefore, were comparing two identical ships, prior to the beginning of their service life, constructed in the same facility, and launched under similar environmental conditions in the controlled environment of a graving dock.

There were no additional or specialized production resources/equipment required to apply the International Paint Interspeed 5640 to the ship's hull.

6.0 Evaluation and Analysis Methods

The analysis of the samples was conducted by an Environmental Laboratory Accreditation Program (ELAP) Certified Laboratory, to ensure the integrity of the data. Samples were filtered and acidified in the laboratory for analysis of total and dissolved copper by inductively coupled plasma-mass spectrometry (ICPMS) according to EPA Method 1640.

The analysis results of the MLP 1 and MLP 2 water sampling events are summarized in the graph of Figure 3.

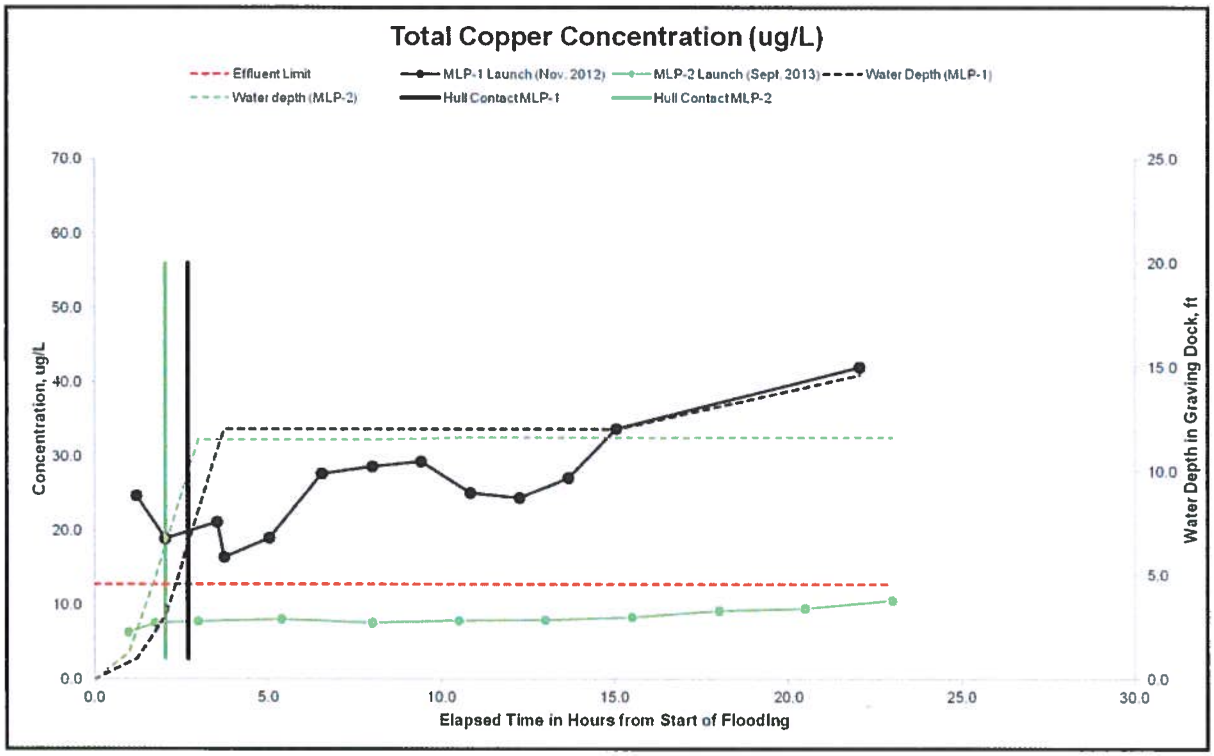

Figure 3: Change in Copper Concentration MLP1 to MLP 2

The graph indicates that the change to a non-copper based AF coating system significantly reduces the copper concentration in the graving dock flood-water. The water copper concentration in the 23rd hour of the MLP 2 float-out is only 24% of the concentration observed during the float-out of MLP 1. Figure 3 also indicates that along with some Best Management Practices (BMPs) that had been implemented prior to the float-out of MLP 1, the use of the non-copper-based AF coating has successfully helped NASSCO achieve the local copper concentration limit set by the San Diego Regional Water Quality Control Board of 12.8 μg/L.

7.0 Time Estimate

Each float-out evolution lasted 24 hours. Results were available from the independent laboratory approximately 4 weeks after the sampling event. Results were summarized and evaluated within one week of receiving the results. MLP 1 and MLP 2 were launched on-time nearly a year apart according to their planned milestone construction schedules. This resulted in both ships being floated-out in very similar environmental conditions.

Coating of the ship's hull with the non-copper-based International Paint Interspeed 5640 was accomplished to plan and was done in the same amount of time as the coating process used for copper-based International Paint Interspeed 640.

8.0 Limitations or Constraints

Beyond attempting to control the environmental factors mentioned in the earlier sections, there were no limitations or constraints to performing the testing and analysis.

There were no production limitations or constraints in applying the non-copper-based Interspeed 5640 AF coating.

9.0 Major Impacts on Shipyard

From a testing and analysis standpoint, there were no major impacts to the shipyard beyond the additional cost and schedule coordination necessary for the project. Tests were conducted in parallel to the float-out of the vessels and the analysis was performed by an outside laboratory.

There were no major impacts to NASSCO's production processes in using the non-copper-based International Paint Interspeed 5640 which was applied to MLP 2 with the same tooling and in the same facility as the copper-based International Paint Interspeed 640 copper-based AF coating used on MLP 1.

10.0 Cost Benefit Analysis / ROI

This testing and analysis project was performed to evaluate the reduction of copper effluent with the use of a non-copper-based AF paint. The project's benefit therefore is achieved in confirming that the use of a non-copper-based AF paint does indeed reduce the copper effluent observed during launching operations, and reduces it to an extent that contributes to meeting mandatory limits set by local and federal regional water quality standards. The results of this project clearly indicate that the copper effluent was significantly reduced, allowing NASSCO to meet the 12.8 μg/L limit imposed by the San Diego Regional Water Quality Control Board (inclusive of the best management practices instituted prior to the float-out of MLP 1).

11.0 Lessons Learned

Beyond the results of the analysis, there were no additional outcomes from this project that should be considered under typical "lessons learned" criteria. The procedures employed by NASSCO during testing have been refined over time and are considered to be both effective and cost efficient for this type of sampling work.

12.0 Technology Transfer

A final project briefing was given at a joint Environmental/Surface Preparation and Coating Panel meeting in Jacksonville, Florida on April 22, 2014. The presentation was well received by both panels. Additionally this Project Results Template and Final Technical Report are available to the U.S. Shipbuilding and Ship Repair Industry for review.