This document includes the Summary of Impacts – Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group 14 for the Draft "Hull Coating Leachate" report published in August 2003. The reference number is: EPA-842-D-06-002

DRAFT
Discharge Assessment Report
Hull Coating Leachate

Summary of Impacts and Characterization for Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group 14

August 2003

4 Summary of Impacts – Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

The largest vessel hull category (i.e., most vessels and wetted hull area) to be evaluated for the Hull Coating Leachate discharge is the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group. Approximately 2,600 vessels are included in this group with a total wetted surface area of 2.5×10^7 square feet. The vessel group accounts for 85% of vessels that produce this discharge and 91% of the total wetted hull surface area (of vessels that produce the Hull Coating Leachate discharge). The USS NIMITZ (CVN 68) was chosen as the vessel class on which to conduct analyses for this group.

4.1 Characterization of Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

Approximately 86% of vessels in the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group use copper ablative antifouling coatings, while the remaining 14% of vessels use vinyl antifouling coatings (Shimko and Tock, 2003). The baseline discharge from this vessel group is a result of constituents leaching from these coatings. A combination of information received from coating manufacturers and government studies are the basis for all estimated and calculated concentrations and release rates. Copper ablative coatings have an estimated service life of 12 years on a USS NIMITZ class vessel.

Constituent concentrations at 1 cm from the hull and release rate information for the baseline discharge are presented in Table 4-1. As discussed in the *Hull Coating Leachate ChAR*, any volatile organic compounds (VOCs) present in coatings were assumed to dissipate during the coating drying/curing process and are not included in the list of constituents discharged from the various coatings characterized.

Table 4-1. Constituent Information for the Baseline Discharge of the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

Constituent	Concentration at 1 cm from the Hull (µg/l)	Release Rate (µg/cm^2/day)		Constituent Mass Loading (lb/vessel group-year)	TPE (lb-equiv/yr)	BCC Identified
		Static	Dynamic			
Copper Ablative Coatings						
Total Copper	5.3[b]	8.9[b]	17.0[b]	99,000	180,000	Reduction
Total Iron	0.26[c]	0.44[c]	0.84[c]	4,900		No
N-ethyltoluenesulfonamide	0.31[c]	0.52[c]	1.2[c]			No
Plasticizer	0.28[c]	0.47[c]	1.1[c]			No
Polyamide resin	0.28[c]	0.47[c]	1.1[c]			No
Rosin	1.0[c]	1.6[c]	3.8[c]			No
Total Zinc	2.1[c]	3.6[b]	6.7[b]	40,000	2,700	Reduction
Vinyl Antifouling Coating						
Total Copper	6.8[c]	12[c]	22[c]	22,000	39,000	Reduction
N-ethyltoluenesulfonamide	0.68[c]	1.1[c]	2.2[c]			No
Rosin	2.2[c]	3.7[c]	6.9[c]			No
Vinyl Chloride-Vinyl Acetate Copolymer	0.68[c]	1.1[c]	2.2[c]			No

[a]Manufacturer information.
[b]Previous Navy Studies.
[c]Scaled from weight percentage or known release rate.

A complete description of the information collected, assumptions, and scaling calculations to estimate the concentrations and release rates is contained in the *Hull Coating Leachate ChAR*.

4.1.1 Establish a Maximum Allowable Copper Release Rate for Antifouling Coatings

The discharge from this MPCD option group is the same as the baseline discharge. Information presented in Section 4.1 for the baseline discharge pertains to the discharge from this MPCD option group. Additional characterization and calculations were not necessary.

4.1.2 Foul-Release Coatings

As described in Section 3.2.2, the unique surface chemistry of foul-release coatings creates a surface to which fouling cannot easily adhere (NRL, 1997). The U.S. Environmental Protection Agency (EPA) has determined that foul-release coatings are exempt from reporting under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (Public Law 95-396), because biocides are not released to control biofouling. The release of any other constituents that may be present in Intersleek 425 is expected to be negligible. Therefore, toxic or hazardous constituents were assumed not to be released to the environment. Discharge characterization data is not presented.

International Intersleek 425 is the only foul-release coating approved for use on Armed Forces vessels, and it is used as the basis for this analysis. International Intersleek has a service life of three years on vessels in the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group.

4.1.3 Advanced Antifouling Coatings

Advanced antifouling coatings can offer environmental benefits because the quantity of copper can be reduced or eliminated and non-persistent biocides can be incorporated. The USCG has approved one copper-free advanced antifouling coating for use on smaller, aluminum-hulled USCG vessels – *E Paint SN-1* (USCG, 2000). This coating contains the patented, non-metallic, biocide Sea-Nine211®. *E Paint SN-1* has a maximum service life of two years and is more durable and easier to maintain than foul-release coatings (USCG, 2000). Advanced antifouling coatings have failed to meet the minimum performance requirements in MIL-PRF-24647 and are not qualified for use on Navy vessels (Lawrence, 2003).

The advanced antifouling coatings MPCD option was analyzed on the basis that all vessels in this vessel group would be coated with *E Paint SN-1*. Table 4-2 presents the constituent information from the discharge of advanced antifouling coatings. The release rate of constituents from advanced antifouling coatings is not as dependent on the vessel movement as for ablative coatings. Therefore, only one release rate value is reported for each constituent. Information supplied from the E Paint Company was the major source of information for the discharge.

Table 4-2. Estimated Constituent Information for the Discharge from the Use of Advanced Antifouling Coatings on All Vessels in the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

Constituent	Concentration at 1 cm from the Hull (µg/l)	Release Rate (µg/cm^2/day)	Constituent Mass Loading (lb/vessel group-year)	TPE (lb-equiv/yr)	BCC Identified
Sea-Nine211® (4,5-dichloro-2-n-octyl-4-isothiazolin-3-one)	1.0[c]	1.8[a]	21,000	440,000	No
Total Zinc	10[c]	17[c]	200,000	14,000	Reduction

[a]Manufacturer information.
[b]Previous Navy Studies.
[c]Scaled from weight percentage or known release rate.

A complete description of the information collected, assumptions, and scaling calculations to estimate the concentrations and release rates is contained in the *Hull Coating Leachate ChAR*.

4.2 Feasibility Impact Analysis of the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

The feasibility analysis assessed the practicability and operational impact of the three MPCD options groups as well as the possible cost to implement each MPCD option. The choice of hull coating directly affects a vessel's ability to satisfy mission requirements as well as the normal drydocking and maintenance schedules for vessels. Costs were estimated to implement each MPCD option. All MPCD options are estimated to incur costs to modify the existing military specification, manuals, and contracts that determine which coating may be used on vessels. Additional costs were estimated for the increased maintenance and application of coatings resulting from the use of the MPCD options.

The MPCD option to Establish a Maximum Allowable Copper Release Rate for Antifouling Coatings results in additional costs due to the need to modify existing military specifications and manuals to incorporate the release rate standard. The currently used copper-containing coatings are the basis for this MPCD option and no additional impacts are estimated.

Foul-release coatings allow marine organisms to grow on the hull and rely on the flow of water over the hull or hull cleaning to remove any fouling that does not grow on the hull during periods of inactivity. Significant impacts on mission capabilities are assumed to result from the use of foul-release coatings due to the difference between operating cycles of Armed Forces vessels and commercial vessels for which the coatings have been proven effective. In addition, foul-release coatings have an estimated three-year service life on a USS NIMITZ Class vessel, resulting in an increased drydocking and coating application schedule as well as additional costs for the Armed Forces.

Commercially available advanced antifouling coatings are not as effective as copper-containing coatings at preventing hull fouling over extended periods. The advanced antifouling coating approved for use by the USCG fouls too quickly for Navy applications, does not satisfy the Navy performance requirements in MIL-PRF-24647, and can not be used on Navy vessels (Lawrence, 2003). Significant impacts on mission capabilities are expected to result from the use of the currently approved advanced antifouling coatings due to the limited effectiveness of the biocide. In addition, advance antifouling coatings would be expected to have a maximum two-year service life in the hypothetical case of application on a USS NIMITZ Class vessel resulting in an increased drydocking and coating application schedule as well as additional costs for the Armed Forces.

A summary of the feasibility impacts by vessel group and MPCD option is presented in Table 4-3.

Table 4-3. Feasibility Impact Summary of the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

MPCD Option	Analysis Factors				
	Mission Capabilities	**Drydock and Pierside Maintenance**	**Initial Costs ($K, in 1999 dollars)**	**12-Year Recurring Costs ($K, in 1999 dollars)**	**Annualized Total Ownership Costs ($K, in 1999 dollars)**
Establish Maximum Copper Standard	None	None	42	1,500	130
Foul-Release Coatings	Reduces speed, range, and mission availability	Significantly increases drydocking frequency and maintenance	48	7,000	580
Advanced Antifouling Coatings	Reduces speed, range, and mission availability due to greater fouling.	Significantly increases drydocking frequency and maintenance	73	9,300	770

A complete description of the assumptions, impacts, and costs is contained in the *Hull Coating Leachate FIAR.*

4.3 Environmental Effects Analysis of the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

The environmental effects were analyzed for the baseline discharge and discharges resulting from each MPCD option. Copper-containing coatings are the basis for the baseline discharge.

For purposes of this analysis, the MPCD option to Establish a Maximum Allowable Copper Release Rate for Antifouling Coatings is not expected to alter the baseline discharge, but is anticipated to limit use of high copper release coatings in the future.

The foul-release coatings MPCD does not result in any biocidal constituents being released to the surrounding water as a means of controlling fouling. However, the inability of these coatings to deter fouling from adhering to the hull may increase the likelihood of transfer and release of nonindigenous species. The need to reapply foul-release coatings more frequently than copper-containing coatings also results in additional VOCs emissions and solid waste generation. The impact of potential nonindigenous species release and other potential impacts from foul-release coatings cannot be quantified with existing data, but may be significant depending on vessel operation.

The advanced antifouling coatings MPCD results in a decrease in the number of BCCs identified and exceedences of water quality criteria over the baseline copper-containing coatings. The total quantity discharged is estimated to be greater, but the advanced antifouling coating constituents have few known environmental impacts. Additionally, the active ingredient in the USCG-approved *E Paint SN-1* is not persistent in the environment. The impact of potential nonindigenous species release and other potential impacts from advanced antifouling coatings cannot be quantified with existing data, but may be significant depending on vessel operation.

A summary of the environmental effects of the Hull Coating Leachate discharge from the various MPCD options and baseline for this vessel group were evaluated and are summarized in Table 4-4.

Table 4-4. Summary of EEA for the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

	Baseline Discharge	**Establish Maximum Copper Standard**	**Foul-Release Coatings**	**Advanced Antifouling Coatings**
Number of Constituents Exceeding Strictest WQC	1	1	0	0
Total Number of Exceeded WQC	Copper Ablative Coatings: Acute: 19 Chronic: 16 Vinyl Antifouling Coatings: Acute: 20 Chronic: 17	Copper Ablative Coatings: Acute: 19 Chronic: 16 Vinyl Antifouling Coatings: Acute: 20 Chronic: 17	0	0
Number of Exceeded Narrative Categories	0	0	0	0
Discharge Hazard Index at 35 m Edge of Mixing Zone	Copper Ablative Coatings: 7.0×10^{-3} Vinyl Antifouling Coatings: 9.8×10^{-3}	Copper Ablative Coatings: 7.0×10^{-3} Vinyl Antifouling Coatings: 9.8×10^{-3}	0	5.7×10^{-3}
Potential Nonindigenous Species Release	Baseline	Baseline	Increased from baseline	Increased from baseline
Number of BCCs Identified	2	2	0	1
Discharge Mass Loading of All Constituents (lb/yr)	170,000	170,000	0	220,000
Discharge TPE (lb-equiv/yr)	220,000	220,000	0	450,000
Other Environmental Impacts -- VOC emissions, solid waste generated	Baseline	Baseline	Increased from baseline	Increased from baseline

In summary, foul-release coatings have a discharge TPE of zero, are unlikely to result in any WQC exceedences, and contain no identified BCCs. Therefore, the use of foul-release coatings would result in the least environmental impact. While advanced antifouling coatings have a discharge TPE of 450, 000 lb-equiv/yr, the biocide is non-persistent. Additionally, advanced antifouling coatings are unlikely to result in any WQC exceedences and contain one identified BCC. The MPCD Option to Establish Maximum Allowable Copper Release Rate Standard for Antifouling Coatings has a discharge TPE of 220,000 lb-equiv/yr that is produced by persistent biocides, results in copper concentrations that are most likely to exceed WQC, and contains two BCCs. None of the MPCD options is expected to result in acute toxicity 35 m from the hull.

For the Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group, MPCD ranking by overall environmental effect is:

1. Foul-Release Coatings
2. Advanced Antifouling Coatings
3. Establish Maximum Allowable Copper Release Rate Standard for Antifouling Coatings

Additional information on the environmental effects analysis is included in the *Hull Coating Leachate EEAR*.

4.4 Cost-Effectiveness Analysis of the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

As a means of comparing the various MPCD options, the incremental pounds removed for each MPCD option is compared to the baseline discharge. These pounds are then compared with the incremental cost of each MPCD option. Finally, a cost per pound removed is calculated and used to compare the MPCD option cost-effectiveness. The comparison results are presented in Table 4-5. As shown below, the use of foul-release coatings would remove 220,000 TPE discharged from baseline at an incremental cost of $460,000,000 per year resulting in an incremental cost of $2,100 per lb-equiv removed. The use of advanced antifouling coatings would increase the total quantity discharged from baseline by 230,000 pounds, as noted by the "-230,000," at an incremental cost of $640,000,000 per year.

Table 4-5. Cost-Effectiveness Analysis of MPCD Options for the Steel, Composite, and Other Non-Aluminum Rigid Hulls Vessel Group

	Establish Maximum Copper Standard	Foul-Release Coatings	Advanced Antifouling Coatings
Incremental TPE Removed from Baseline (lb-equiv removed/yr)	0	220,000	-230,000
Incremental Annualized Cost from Baseline ($K, in 1999 dollars)	3.5	460,000	640,000
Incremental Cost per TPE Removed ($/lb-equiv removed)	N/A	2,100	N/A

N/A = The incremental cost per pound removed is not applicable when the incremental TPE removed increases and the incremental annualized cost decreases or when the incremental TPE removed is zero.