This document includes the Cover Page, Table of Contents, and Introduction to the EPA "Draft Characterization Report for Hull Coating Leachate" published in August 2003. The reference number is: EPA842-D-06-001

DRAFT
Characterization Report
Hull Coating Leachate

Table of Contents, Introduction, Vessel Groups, Marine Pollution Control Device Option Groups, Characterization Data, and Uncertainty Information

August 2003

DRAFT

CHARACTERIZATION ANALYSIS REPORT

Hull Coating Leachate

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U.S. Environmental Protection Agency

August 2003

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LIST OF ACRONYMS

ASTM	American Society for Testing and Materials
CAS	Chemical Abstracts Service
CFR	Code of Federal Regulations
ChAR	Characterization Analysis Report
EPA	Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
IMO	International Maritime Organization
MESO	Marine Environmental Support Office
MPCD	Marine Pollution Control Device
MSDS	Material Safety Data Sheet
OAPCA	Organotin Antifouling Paint Control Act
ORTEPA	Organotin Environmental Programme Association
RIB	Rigid Inflatable Boat
TBT	Tributyltin
UNDS	Uniform National Discharge Standards
UNDSMIS	Uniform National Discharge Standards Management Information System
USCG	United States Coast Guard
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The purpose of the Characterization Analysis Report (ChAR) is to provide the information necessary to conduct the feasibility and environmental effects analyses. In 40 CFR Part 1700, hull coating leachate was identified as a discharge requiring control for vessels of the Armed Forces and defined hull coating leachate as "…constituents that leach, dissolve, ablate, or erode from the paint on the hull into the surrounding seawater." As such, the information addressed in this ChAR includes the chemical constituents, release rates, and release quantities of constituents discharged from the underwater hull coatings of Armed Forces vessels, and an analysis of hull coating alternatives.

Armed Forces vessels use several underwater hull coating systems. These underwater hull coating systems are divided into coatings intended to control marine fouling and coatings intended to prevent corrosion of the hull. For the purpose of hull coating leachate discharge, hulls coated with coatings that only control corrosion are not included because constituents are not released into the water from these systems. Only coatings that control marine fouling growth are included in the hull coating leachate discharge.

Fouling control coatings can be broadly grouped into two categories. The first category includes the current antifouling coatings used on Armed Forces vessels (i.e., copper-containing antifouling coatings and advanced antifouling coatings). Copper-containing antifouling coatings are complex mixtures of resins, pigments (e.g., zinc oxide, iron oxides, carbon black, etc.), thickeners, and biocides such as cuprous oxide, copper thiocyanate, or other copper compounds that serve as biocides releasing copper when exposed to seawater). Copper ablative coatings, which are designed to wear or ablate away as a result of water flow over a hull, and vinyl antifouling coatings, which release copper as a result of copper leaching and hydrolysis of rosin particles, are the most predominantly used copper-containing coatings. Advanced antifouling coatings use the short half-life, non-metallic biocide (Sea-Nine211®) to control fouling. Biocidal coatings are applied to the majority of Armed Forces vessels. The copper and zinc based biocides exhibit high efficacy against marine fouling organisms. The second category of coatings that are used to control fouling on Armed Forces vessels is categorized as foul-release coatings. Foul-release coatings, typically based on silicone resins and oils, do not contain biocides, but rely on a smooth, low energy surface to inhibit fouling organism adhesion to a ship's hull. These foul-release coatings may inhibit fouling organism adhesion to the ship's hull so effectively that the hydrodynamic drag, created by the ship moving through the water, dislodges any organisms that start to grow on the hull.

1.1 VESSEL GROUPS

To facilitate feasibility and environmental effects analyses, vessel classes that produce hull coating leachate were arranged into vessel groups according to hull material and associated antifouling coating type. A specific vessel class was selected for each vessel group to facilitate discharge analyses. A complete discussion of the methodology and rationale is discussed in the

Vessel Grouping and Representative Vessel Selection for Hull Coating Leachate Discharge (EPA and Navy, 2003c). The hull coating leachate vessel groups and vessel classes chosen to facilitate analyses are:

- Steel, Composite, and Other Non-Aluminum Rigid Hulls: USS NIMITZ (CVN 68),
- Flexible Hulls (non-aluminum): USS LOS ANGELES (SSN 688), and
- Aluminum Hulls: 47-ft Motor Lifeboat (MLB 47).

The Steel, Composite, and Other Non-Aluminum Rigid Hulls vessel group encompasses most Armed Forces vessels. There is considerable variability in size and design among vessels in this group. Vessels in this group range from small boats to aircraft carriers that are over 1,000 feet long. For the purpose of these analyses, the CVN 68 class of aircraft carrier was selected to facilitate analyses for this class because:

- as a vessel type, aircraft carriers have among the greatest wetted-hull surface area of this vessel group;
- all aircraft carriers use standard copper ablative coatings; and
- the CVN 68 Class vessels are still under construction and are expected to remain in service for decades.

Vessels with the largest surface area are anticipated to release the greatest mass of hull coating leachate because the leach rate is measured on a per unit area basis and is independent of hull substrate material.

The Flexible Hulls vessel group includes ships with underwater hulls covered by flexible elastomeric materials. The Flexible Hulls vessel group includes 58 submarines, distributed among three classes with roughly the same wetted hull area, and the MCM 14, a mine countermeasure vessel in the USS AVENGER (MCM 1) class (Mine, 2002). The SSN 688 class of attack submarines was selected as the representative vessel class for this group. This class has 51 submarines in service and comprises approximately 86% of the number of vessels in the group. Copper ablative coatings are the primary antifouling coating used on this vessel group, but these coatings crack as a result of the elastomer compressing more than the antifouling coating system when the vessel dives to operating depth. The cracking of these coatings is an ongoing maintenance issue. The Navy has active efforts to identify antifouling coatings that are more flexible for use on flexible hulls.

The Aluminum Hulls vessel group includes numerous classes of smaller vessels used by the Armed Forces. Vessels with aluminum hulls include boats and craft ranging from less than 20 feet long to 192 feet in length. Armed Forces coating policy prohibits the use of copper-containing coatings on vessels in this group. Copper-containing coatings are not used on aluminum hulls to minimize the potential for deposition corrosion at coating defects (ASM, 1987; Jones, 1992; Lamtec, 2001). More information on deposition corrosion is discussed in the *Feasibility Impact Analysis Report: Hull Coating Leachate* (EPA and Navy, 2003d). Due to this prohibition on copper-containing coatings, craft in the Aluminum Hulls vessel group are coated with either foul-release coatings or coatings that use zinc-based and/or non-metallic biocides. The USCG's most recent motor lifeboat class, the MLB 47, was selected as the representative

aluminum hull vessel because it is one of the larger Armed Forces vessels with an aluminum hull, is a relatively numerous vessel class (i.e., over 71 vessels in service), and its operational parameters are consistent with the majority of aluminum craft operated by the Armed Forces.

1.2 MARINE POLLUTION CONTROL DEVICE OPTION GROUPS

After evaluating various technologies, three MPCD option groups passed the initial screening process for the hull coating leachate discharge:

- Establish a maximum allowable copper release rate for antifouling coatings,
- Foul-release coatings, and
- Advanced antifouling coatings.

The following sections provide a short overview of each option group. Additional details about these option groups are included in the respectively named hull coating leachate MPCD screens (EPA and Navy, 2002, 2003a, 2003b).

1.2.1 Establish a Maximum Allowable Copper Release Rate for Antifouling Coatings

For Armed Forces vessels coated with antifouling products qualified under the military specification MIL-PRF-24647, the biocide released into the water to prevent the growth of marine fouling organisms is the copper from cuprous oxide or other copper-containing compounds included in the coatings (Navy, 2001a). This MPCD option group would establish a maximum allowable copper release rate from current and future copper-containing antifouling coatings. If this MPCD option group is chosen, it will prevent the use of higher release rate copper-containing coatings in future applications.

1.2.2 Foul-Release Coatings

The foul-release coatings MPCD option would essentially eliminate hull coating leachate by adopting the use of these silicone-based hull coatings that inherently do not release any biocidal constituents. Instead, these coatings rely on a smooth low-energy surface to inhibit the adhesion of fouling organisms to the hull and to release attached organisms when the vessel achieves a critical speed (usually in excess of 15 knots). Foul-release coatings are listed as a category in military performance specification MIL-PRF-24647, and one product of this type is approved for use on USCG and Navy vessels. Use of the currently approved foul-release coating on Armed Forces vessels is limited because foul-release coatings are far more vulnerable to damage from abrasion due to contact with fenders or tugs, scratches due to impact with ice or debris, and hull cleaning than currently approved copper-containing products. For example, foul-release coatings are used on less than 1% of Navy vessels, are not used on any submarines, and are used on fewer than 10% of USCG vessels. The environmental effects and feasibility analyses for the foul-release coatings MPCD option consider the increased use of foul-release coatings in the Armed Forces to the entire vessel group (EPA and Navy, 2003d; EPA and Navy, 2003e).

1.2.3 Advanced Antifouling Coatings

The advanced antifouling coatings MPCD option would adopt the use of a short half-life non-metallic biocide (i.e., Sea-Nine211®) to either replace copper and zinc based biocides, or may be used as a co-biocide. Short half-life non-metallic biocides are intended to control fouling at the coating surface, but degrade rapidly in the water into benign byproducts. Advanced antifouling coatings are currently being tested on Armed Forces vessels. The USCG has already approved one advanced antifouling coating that uses Sea-Nine211® to control fouling on smaller USCG vessels with aluminum hulls (USCG, 2000). The USCG-approved non-metallic biocide coating performs effectively for less than two years in areas with a high fouling growth rate (e.g., Miami, FL and Ingleside, TX). Currently, advanced antifouling coatings have not satisfied the Navy performance requirements in MIL-PRF-24647. However, advanced antifouling coatings are being tested and may satisfy the MIL-PRF-24647 requirements in the future. The Navy continues to evaluate advanced antifouling coatings and believes these coatings offer the greatest potential as a future MPCD to reduce or eliminate copper hull coating leachate. In the case of advanced antifouling coatings that use copper as a co-biocide, the Navy has stated that advanced antifouling coatings should emit less copper than is currently released from the copper-ablative products approved under MIL-PRF-24647 to be considered an environmentally acceptable product by the Navy (Ingle, 2002). This goal is to ensure that advanced antifouling coatings have a reduced environment impact when compared to currently approved copper-containing coatings.

1.3 CHARACTERIZATION DATA

For this ChAR, the Characterization Data sections present all data and information found to support the environmental effects and feasibility impact analyses. These sections are organized by vessel group with subsections for each MPCD option. If an MPCD option was determined to be not feasible for a vessel group, such a statement and justification is made and characterization data are not presented. The following sections describe the types of data that are presented in this analysis.

1.3.1 Physical Parameters

In the Physical Parameters sections of this report, vessel class information is presented. Because modeling is not being used in the environmental effects analysis, information on vessel size, underwater hull wetted area, number of vessels in the vessel group, number of days in U.S. ports, and number of days in transit between 0 nm and 12 nm of U.S. shoreline are the only physical parameters necessary for the characterization of the discharge from each vessel class (EPA and Navy, 2003e). All vessel physical parameter information was obtained from the Uniform National Discharge Standards Management Information System (UNDSMIS) database and the *Vessel Grouping and Representative Vessel Selection for Hull Coating Leachate Discharge* (EPA and Navy, 2003c).

1.3.2 Constituent Data, Classical Data, and Other Descriptors

Chemical Data

The Chemical Data section of this report presents the chemical constituents in the coatings and estimated discharge for each baseline condition and MPCD option group, as well as all

information obtained from available studies conducted on the coatings in each MPCD option group. These studies present constituent release rate information, harbor sampling data, and qualitative information on the effect of water temperature on copper release rates from the ablative coatings currently used on the majority of Armed Forces vessels. While several government studies have been conducted on copper release rates from ablative coatings, studies have not been conducted on foul-release, advanced antifouling, or vinyl antifouling coatings. A manufacturer of an advanced antifouling coating supplied constituent release rate information but did not supply the supporting studies that generated the release rate information. As a result of the limited data available, information on the constituents contained in each coating was obtained from coating manufacturers' material safety data sheets (MSDSs). Due to coating manufacturer confidentiality concerns and MSDS reporting requirements, a complete list of constituents was not obtained for any of the coatings. Some of the MSDSs reported a weight percentage range for each constituent. For some coatings, the maximum weight percentage was reported; but for others, the midpoint of the range was used to ensure the total weight percentage did not exceed 100%. The constituent names as well as the weight percentage of biocides and other constituents in the coating are presented in tables for each coating. Some coatings may contain constituents in their formulations that may leach, but are not intended to be, nor act as, biocides. These constituents are not included in the subsequent descriptions.

Field Information

Field information (i.e., classical data) is typically collected at the time of sampling and includes data such as temperature, pH, salinity, specific conductance, and free and total chlorine. The Hull Coating Leachate discharge has not been sampled in the UNDS program. Consequently, field information is not reported in this section of the ChAR.

Descriptive Information

Descriptive information includes color, floating materials, odor, settleable materials, turbidity/colloidal matter, and other parameters related to narrative water quality criteria. Hull coating leachate is not discharged from a pipe, but slowly released from the entire underwater hull of a vessel. Existing studies of hull coating leachate have not collected or reported such descriptive information. Descriptive information is not reported in this document. Due to the rate and nature of the constituents released, this discharge is expected to have negligible affects on parameters related to narrative water quality criteria.

1.3.3 Discharge Generation Rates for Mass Loading

This section of the report presents discharge generation rates for the constituents released in each MPCD option for the vessel group used for analysis.

1.4 UNCERTAINTY INFORMATION

As described in *Environmental Effects Analysis Guidance for Phase II Uniform National Discharge Standards (UNDS) for the Vessels of the Armed Forces* (EPA and Navy, 2000a), an assessment of the uncertainty of data collected, assumptions, estimations, and calculations should

be made. The ChAR is the basis for the environmental effects analysis and includes an uncertainty discussion. This section of the report addresses any uncertainty associated with the assumptions, data, estimates, and calculations. Uncertainty information will be addressed for the baseline discharge and for each MPCD option group.