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CONVENTION ON THE PREVENTION OF MARINE POLLUTION BY DUMPING OF WASTES AND OTHER MATTER, 1972 AND ITS 1996 PROTOCOL

Revised guidance on best management practices for removal of anti-fouling coatings from ships

1 The governing bodies of the London Convention and Protocol, at their joint session in October 2023, approved the *Revised guidance on best management practices for removal of anti-fouling coating from ships*, as set out in the annex, and agreed to issue this Revised Guidance as an LC/LP circular.

2 The Revised Guidance has been updated following the amendments to the AFS Convention to introduce controls on cybutryne, which were adopted by MEPC at its seventy-sixth session in June 2021 and entered into force on 1 January 2023. The Guidance attached at annex replaces the 2014 *Guidance on best management practices for removal of anti-fouling coatings from ships, including TBT hull paints*, contained in LC-LP.1/Circ.38/Rev.1.

3 Contracting Parties are invited to bring this circular to the attention of all concerned.

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ANNEX

REVISED GUIDANCE ON BEST MANAGEMENT PRACTICES FOR REMOVAL OF ANTI-FOULING COATINGS FROM SHIPS

1 BACKGROUND AND INTRODUCTION

1.1 Anti-fouling systems are used on ships' hulls to limit the effect fouling can have on drag, fuel consumption and the emission of combustion products. They may contain pesticides or be pesticide-free. Throughout history, several biocides have been employed in anti-fouling systems. Some of them, which were proven to pose unacceptable threats to aquatic life, were restricted or even banned on their use at regional or international scale. The most effective biocidal anti-fouling systems are formulated as self-polishing polymer coatings that wear away as the ship is propelled through the water, to expose a fresh layer of biocide. Biocides that leach into water from ships' hulls may adversely affect non-target organisms. Anti-fouling coating removal activities can be another major source for the release of biocide agents to the environment. The choice of anti-fouling system, and the collection, treatment and disposal of spent coatings have an impact on the release of biocides into the environment, and may result in high concentrations of biocides in the marine sediments in areas close to where application and removal activities are conducted. The adoption of sound management practices for the application and removal of anti-fouling systems can reduce the release of biocides into the natural environment.

1.2 By their nature, all anti-fouling biocides are toxic and can affect a broad range of organisms beyond those that cause fouling. The best-known case is tributyltin (TBT), the widely used anti-fouling agent in the 1970s and 1980s. TBT was found to cause reproductive anomalies and population effects in certain species of marine snails at concentrations in the parts-per-trillion range and has been implicated in endocrine effects on other organisms. Oysters exposed to low levels of TBT were shown to develop shell deformities that reduce their value as seafood. TBT was also associated with immune suppression and other adverse effects in other marine species. Another example of a broad-acting antifoulant agent is cybutryne, known also as Irgarol, an environmentally persistent algaecide which, besides target organisms, was proved to also affect primary producers and vulnerable ecosystems such as coral reefs.

1.3 The International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention), which entered into force on 17 September 2008, prohibited new applications of TBT and other organotin compound (OTC) based anti-fouling paints on ships and required their removal from or overcoating on hulls. In 2021, MEPC 76 adopted amendments to the AFS Convention by way of resolution MEPC.331(76) and introduced controls on cybutryne which entered into on 1 January 2023 (MEPC 76/15 and MEPC 76/15/Add.2, annex 4). Cybutryne is one of the herbicides within the triazine family which act to reduce plant photosynthetic ability. It is often combined with copper or copper compounds in anti-fouling paints as a booster biocide. Cybutryne is not readily biodegradable; its abiotic degradation in seawater is very slow and it affects photosynthesis in primary producers by blocking electron transport. This inhibition ultimately leads to reduced carbon dioxide uptake, decreased carbohydrate production and the eventual starvation of the plant. Cybutryne can therefore threaten a variety of habitats – from coral reefs and seagrass beds to open moorings. Its primarily herbicidal properties mean that coral zooxanthellae, phytoplankton and periphyton are particularly vulnerable.

1.4 Large amount of biocide-containing waste are generated at shipyards and other facilities operating the removal of the anti-fouling paints to achieve compliance with the AFS Convention. Considering the high potential for toxicity of this hazardous material, possible risks for the environment can derive from its mismanagement.

1.5 As stated in annex 2, paragraph 4, of the London Protocol, for dredged material, the goal of waste management should be to identify and control the sources of contamination. This should be achieved through implementation of waste prevention strategies, and requires collaboration between the relevant local and national agencies involved with the control of point and non-point sources of pollution.

1.6 For these reasons, in 2006, the Scientific Groups established under the London Convention and Protocol began to develop guidance on Best Management Practices (BMPs) for removal of anti-fouling coatings from ships. The Scientific Groups discussed an initial report of BMPs in June 2007 (LC/SG 30/8 and LC/SG 30/14).

1.7 In November 2007, the governing bodies under the London Convention and Protocol noted that this issue had now become very urgent as the AFS Convention would enter into force on 17 September 2008. MEPC 57 was informed, by way of interim advice, of the information collected in the Scientific Groups on environmentally sound removal methods of anti-fouling systems from ships, resulting in document MEPC 57/INF.2. In May 2008, the Scientific Groups continued their work, as planned, and prepared a "work in progress" report (LC/SG 31/16, annex 11) which was submitted as document MEPC 58/INF.3 and which was, subsequently, adopted by the governing bodies in October 2008.

1.8 Whilst recognizing the limited mandate of the London Convention and Protocol with respect to the control of sources of pollution and activities occurring within internal waters, these BMPs are hereby offered as a tool in the handling and management of AFS substances.

1.9 Since the first issuance of these BMPs in 2009, further related guidance has been developed by IMO. In 2011, MEPC adopted the *Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species* (resolution MEPC.207(62)) (at present under review), and in 2012 the *Guidance for minimizing the transfer of invasive aquatic species as biofouling (hull fouling) for recreational craft* (MEPC.1/Circ.792) was adopted. These two documents include specific information on in-water inspection, cleaning and maintenance (see section 7 of the *2011 Biofouling Guidelines* and section 9 of the *2012 Guidance for recreational craft*), which is not addressed in the present BMPs, but may generate wastes containing anti-fouling material. Interested readers are thus encouraged to refer to the MEPC documents for further information on these topics.

1.10 Recommended further reading and references are set out at the end of this document.

2 GENERAL OVERVIEW

2.1 BMPs generally include two methods:

.1 **source-control methods** (e.g. vessel shrouding, sweeping, covering waste piles, and diked storage for wastes and paints); and

.2 **collection, filtration and treatment methods** (e.g. hull wash water settling tanks and filters). These BMPs depend on some basic requirements for different types of shipbuilding and maintenance facilities.

2.2 AFS waste may be generated during AFS coating removal, in which hull coating layers are removed in preparation for application of a new coating.

2.3 Types of waste associated with removal of anti-fouling coatings include:

.1 surface cleanings to remove fouling organisms, which have the potential to remove paint containing biocides along with the organisms themselves;

.2 paint chips and other paint remnants, either dry from scraping, sanding, etc.; or in washwater, water used in wet blasting;

.3 dissolved biocides and related degradation products, in washwater and water used in wet blasting;

.4 contaminated sand or grit used in blasting; and

.5 biocide-containing paint removed from waste materials by physical means, such as filtration or water treatment.

2.4 This guidance document provides information on methods of AFS removal techniques. Environmentally protective steps for AFS removal waste chains are described, and a bibliography of recommended sources for BMPs and related information is included.

3 BASIC FACILITY REQUIREMENTS[1]

3.1 All facilities in which AFS coatings are removed should follow **good housekeeping practices**, such as thorough record-keeping, securing of materials and equipment, and instruction of workers on good work habits and hygiene.

3.2 Whatever the type of a facility, management is responsible for establishing a **clear framework** for safe operation and assigning responsibilities in support of sound environmental and safety practices. Management should communicate a clear **code of practice** to all personnel. This code of practice should include a description of emergency procedures in response to mishandling or release of waste materials through human error, flooding, fire and other circumstances. The best practices for emergency response will vary based on facility and the specific circumstances of the event, and are not explicitly addressed in this document.

3.3 Facilities in which AFS coatings are removed are widely variable in their level of technological sophistication. Locations not specifically designed or equipped for ship maintenance and repair work may be temporarily established to handle smaller workloads. Other facilities that handle larger volumes of work may be better equipped and may include structures (e.g. dry docks) and trained staff. Everything in between is possible, and special attention should be given to best management practices adaptable to less-well-equipped facilities.

3.4 **Facility design**: At a minimum, all facilities should have an impermeable floor or work surface for dry paint removal (e.g. scraping, grit blasting), with a water collection and containment system for wastewater generated during AFS removal (as may be found in dry docks). The floor should be clean at the start of work and should be thoroughly cleaned after completion of the work. If an impermeable floor is not present, a temporary impermeable surface (e.g. a waterproof tarp) should be installed that guarantees containment of waste materials and safe collection of wastewater. Other necessary environmental and safety provisions shall be undertaken before the work starts, including installation of marked waste containers and the use of personal protective equipment. Removal should be done in indoor areas or areas restricted by sheets so as to minimize the dispersion of biocide particles into the environment. In addition, a suitable air cleaning system is recommended covering removal

[1] The term "facilities" is defined as shipyards, dry docks, boatyards, vessel construction or renovation yards, ports, harbours, marinas, or other related locations where AFS might be removed.

of AFS and recovery of dust, waste materials and sandblasting debris from the air. Details on the design and the construction of impermeable floors and other features can be found in the recommended further reading and references (see below).

3.5 **Facility staff**: The facility should have designated staff with responsibility for hull coating waste and wastewater management.

3.6 **Collection of particulate waste and its handling at the facility**: Different types of particulate waste from AFS removal should be stored separately while awaiting treatment and disposal. Storage containers should be clearly marked. Contents of the waste containers should be removed for treatment and/or disposal at an appropriate waste management facility.

3.7 **Safe wastewater collection**: Water contaminated with hull coating waste should be held separately from other liquid materials in storage at the facility until it can be treated. Wastewater should be collected in a closed holding tank or container.

3.8 **Handling of wastewater**: The settled suspended particles should be separated from the supernatant water and transported to a licensed facility for treatment and disposal.

3.9 **Discharge water requirements**: The amount of water to be discharged at a certain date should be reported to relevant authorities.

4 REMOVAL OF ANTI-FOULING SYSTEMS ON LAND

4.1 There are principally three methods for the removal of anti-fouling systems:

.1 **scraping**: sanding, grinding, or scraping by hand or equipment to scrape off the paint;

.2 **blasting**: grit blasting (dry blasting, wet blasting); and

.3 **water blasting/washing** (low, medium and high pressure).

4.2 **Requirements for removal of AFS**: As with all facilities for coating removal, basic requirements for the facility are an impermeable floor or work surface and a means for capturing and containing AFS waste, fouling materials, dust, and, if water is used for removal, water contaminated with waste. As noted in section 3.4, the floor or work surface should be clean at the start of the operation. Structures and materials within the workspace that are not needed during blasting should be removed from the work area. Persons involved in the removal of AFS coatings should wear personal protective equipment (such as, fluid impermeable gloves, face mask, safety glasses, protective suit; respiratory protection is advisable if waste material is likely to become airborne). Owing to the use of high pressure air or water involved and the potential spread of paint over considerable areas, grit blasting is only recommended for an enclosed area or in a dry dock with features allowing the collection of aerosol particles, solids and liquids containing AFS coating residue, including an impermeable work surface and containment system.

4.3 **Preparatory assessment and action for removal of AFS**: If possible, prior to starting the anti-fouling coating removal operation, the facility shall ascertain the type of AFS on the hull. This information may be available on the ship's documentation as required by the AFS treaty. When the type of AFS is known, appropriate measures can be taken during removal, handling, and treatment, and the correct disposal action can be implemented. For example, waste from a non-biocidal coating may be disposed of differently than waste from a biocidal coating. Chemical treatment of waste materials may differ depending on the nature of the biocide.

4.4 AFS can be removed by sanding or grinding the material off the hull. Because these operations are performed with hand tools, the worker is likely to be exposed to dry waste, either in the air or on the skin. Precautions should be taken to reduce worker (and bystander) exposure, such as the use of protective equipment (dust mask, goggles, gloves) and not conducting paint removal on windy days.

4.5 Grit blasting is the most common practice for AFS removal. Abrasive materials used in grit blasting vary; materials can include steel, blasting grit, copper cinder, corundum, aluminium and glass beads. Some rules of thumb for media selection in grit blasting are:

.1 choose the least aggressive media (in terms of mechanical and chemical characteristics); this will result in less wear and lower equipment maintenance expense;

.2 use the smallest media particle size, which is more effective as more impacts per second will yield a faster process; and

.3 find the lowest blast pressure that is effective in removing the coating; doing so will yield energy savings in reduced compressed air requirements and less dispersion of the removed coating, as well as less wear and lower maintenance costs.

4.6 **Operation and waste collection by grit blasting**: Airborne particles from dry blasting can be contained by working in a cabin with an air filtering system, by fine-mesh netting around the facility or by a water screen that catches the particles and allows them to settle on the work floor. These measures are not expected by themselves to reduce inhalation exposure for workers. Measures should be taken to protect workers from grit and particle respiration. Grit blasting accomplished with the use of water should only be undertaken in a facility that has a system to catch and remove airborne particles and wastewater.

5 THE ANTI-FOULING WASTE CHAIN

5.1 AFS may contain toxic material that should be prevented from entering the environment as waste. Steps should be taken to limit exposure for workers and others. A preventive approach in AFS waste collection is advocated. For example, only necessary personnel should be in the area where AFS removal is taking place. Additionally, outdoor jobs without a containment structure should be avoided, and outdoor jobs should not be conducted on a windy day.

5.2 **AFS waste collection**: Different types of waste should be kept in separate containers only intended for that specific type of waste. After completion of the work, the waste containers should be removed for further waste treatment at a specialized facility. Waste should not be removed by washing with water or brushing it into the environment; the waste should also never be buried, incinerated or permanently stored at the facility.

5.3 **AFS wastewater collection**: Water contaminated with hull coating waste should be held separately from other liquid materials in storage at the facility until it can be treated. Wastewater should be collected in a closed holding tank or container. Wastewater contaminated with an AFS during hull coating removal should be left standing so that suspended particles can settle and be physically separated from the water. The supernatant wastewater collected at the AFS removal site should be treated and discharged under an appropriate permit to prevent the introduction of chemical contaminants or invasive species from fouling organisms that may be present in the wastewater.

5.4 **Collection of particulate waste and its handling at the facility**: Dry waste is produced by scraping, grinding and sanding, or by grit blasting. Grit can be reused multiple times. Both spent grit and particulates such as paint chips must be collected and removed from the area after work is completed or daily if the work spans several days.

5.5 **AFS wastewater handling and treatment**: The wastewater collected should be subjected to a system to remove the contaminated waste so as to meet a predefined Total Suspended Solid (TSS) content in the wastewater. A certain particle load – a general rule might be 100 mg/l – shall not be exceeded for discharged water (see Ten Hallers-Tjabbes 2007). The pH of discharged water shall be within certain limits (e.g. between 6.5 and 9 pH units). Treated wastewater meeting predefined national chemical standards may be disposed of through a sanitary sewer system; if so, local sewer authorities should be advised beforehand. Discharges of this AFS contaminated material into sensitive marine areas should be avoided.[2] If methods to remove dissolved AFS components (such as organotins) are available, such wastewater should be treated to remove dissolved components of the anti-fouling coating. The contaminated sediment, having been separated from the wastewater, should be transported to a licensed facility for treatment or safe disposal. In absence of a licensing system for disposal systems, contaminated water and sediment should be directed to a landfill lined with an impermeable liner to prevent leaching of waste materials into ground or surface water.

5.6 **AFS waste chain for grit blasting**: Contaminated grit may be re-used after sieving of the broken grit particles and it may be recycled for other purposes or cleaned using thermal cleaning. Separated grit dust and/or contaminated grit that are unfit for reuse or recycling should be disposed of at a licensed facility that is protected from the environment. If the facility is not able to recycle or clean the grit, the contaminated grit and/or sieving waste should be removed and transferred to a facility licensed to clean blasting grit.

5.7 **Grit blasting waste handling**: Wastewater from wet grit blasting should be caught, removed and contained. The grit that remains on the floor should be collected and removed for reuse, recycling, cleaning or safe disposal. Contaminated grit, if not to be reused, or any waste separated from contaminated grit, should be transported to a licensed facility for treatment or safe disposal. In the absence of a licensing system for disposal systems, contaminated grit should be directed to a landfill lined with an impermeable liner to prevent leaching of waste materials into ground or surface water.

6 RECOMMENDED FURTHER READING AND REFERENCES

Best Management Practices

ANZECC – Marine Accidents and Pollution Implementation Group (2000). Code of practice for anti-fouling and in-water hull cleaning and maintenance, 12 pp. http://www.environment.gov.au/archive/coasts/pollution/antifouling/code/pubs/code.pdf

[2] Point source discharges of wastewater to water bodies or the wastewater collection system may be subject to a pre-treatment programme and/or a wastewater discharge permit issued by the country's environmental regulatory agency or state/province. For example, in the United States, a National Pollutant Discharge Elimination System (NPDES) permit may be issued under section 402 of the US Clean Water Act by one of the US States or territories that have specific discharge limits and requirements (http://cfpub.epa.gov/npdes/). Effluent limits, monitoring requirements and reporting requirements that may be applied to discharges from AFS facilities. If the wastewater is considered as an industrial discharge, the waste stream may be subject to pre-treatment requirements (http://cfpub.epa.gov/npdes/home.cfm?program_id=3; or http://cfpub.epa.gov/npdes/home.cfm?program_id=14).

Auckland Regional Council (2005). Auckland guideline for the management of environmental risks from boat maintenance activities, 34-52.

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Connor, J. and Drociak, J. (2001). Best Management Practices for New Hampshire Marinas. New Hampshire Department of Environmental Services, Concord, NH, 79 pp.

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Environment Canada (1995). Best Management Practices (BMPs) for Marinas and small Boatyards in British Columbia. Report by PCA Consultants Ltd., Richmond, BC, 18 pp.

Environmental Protection Agency (EPA) (2005). Shipyard Stormwater Best Management Practice #3: Removal of Hull Biofoulants, 5 pp.

Environmental Protection Authority (2004). Stormwater Management for Marinas, Boat Sheds and Slipways. Report of EPA for the Government of Southern Australia, 4 pp.

IMO (2011). Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species. Resolution MEPC.207(62).

IMO (2012). Guidance for minimizing the transfer of invasive aquatic species as biofouling (hull fouling) for recreational craft. Circular MEPC.1/Circ.792.

IMO (2019). Hull Scrapings and Marine Coatings as a Source of Microplastics. International Maritime Organization, London.
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Ten Hallers-Tjabbes, C.C. (2007). Environmental sound and safe removal of harmful anti-fouling systems and of cleaning of ships' hulls. SAFEMED Project Task 3.8 O Final report. IMO/EC, 98 pp.

Turner A. (2021). Paint particles in the marine environment: An overlooked component of microplastics. *Water Research X* 12:100110. DOI: 10.1016/j.wroa.2021.100110

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Champ, M.A., Fox, T., and Mearns, A.J. (1999). Treatment of regulated discharges from shipyards and dry-docks. Proceedings of the special session held at Oceans '99, Seattle, Washington, Sept. 13-16, 1999. Marine Technology Society, Washington, DC, 230 pp.

Champ, M.A. (2000). A review of organotin regulatory strategies, pending actions, related costs and benefits. *Science of the Total Environment* 258, Issues 1-2, 21-71.

Stichnothe, H., Thoeming, J., and Calmano, W. (2001). Detoxification of tributyltin contaminated sediments by an electrochemical process. *Science of the Total Environment* 266, Issues 1-3, 265-271.

IMO (2019). Remaining amount of cybutryne in an anti-fouling system (AFS). Document PPR 7/6/4 submitted by Japan to the seventh session of the Sub-Committee on Pollution Prevention and Response (PPR).

IMO (2019). Use of anti-fouling paints containing cybutryne on ships and pleasure craft, function and availability of sealer coats which prevent leaching of cybutryne from underlying coatings, and guidance on the control of cybutryne-contaminated dry-docking wastes. Document PPR 7/6 submitted by IPPIC to the seventh session of the Sub-Committee on Pollution Prevention and Response (PPR). Also see: https://www.bimco.org/news/environment-protection/20210618-imo-bans-toxic-paint-substance-cybutryne

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Recommended document downloads

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