ANNEX XX

REVISED GUIDELINES FOR THE CONTROL AND MANAGEMENT OF SHIPS' BIOFOULING

TO MINIMIZE THE TRANSFER OF INVASIVE AQUATIC SPECIES

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TABLE OF CONTENTS

1 INTRODUCTION

1.1 MEPC 62 adopted the 2011 *Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species* (the Guidelines) through resolution MEPC.207(62). The aim of the Guidelines was to provide a globally consistent approach to managing biofouling by providing useful recommendations of general measures to reduce the risk associated with biofouling for all types of ships.

1.2 Member States of the International Maritime Organization (IMO) decided at MEPC 72 to review the Guidelines in order to assess the uptake and effectiveness of the Guidelines and identify any required action.

1.3 Studies have shown that biofouling can be a significant vector for the transfer of invasive aquatic species. Biofouling on ships entering the waters of States may result in the establishment of invasive aquatic species, which may pose threats to human, animal and plant life, economic and cultural activities, and the aquatic environment.

1.4 Invasive aquatic species have been recognized as one of the major threats for the well-being of the oceans by, inter alia, the Convention on Biological Diversity (CBD), several UNEP Regional Seas Conventions, the Asia Pacific Economic Cooperation forum (APEC), and the Secretariat of the Pacific Region Environmental Program (SPREP).

1.5 Prediction of risk for introducing invasive species is complex, hence this Guidelines has the intention to minimize the accumulation of biofouling on ships. Biofouling may include invasive species while a clean hull and niche areas eliminate this risk. Studies have shown that the biofouling process begins within the first few hours of a ship's immersion in water. The biofouling pressure on a specific ship is influenced by a range of factors, starting with design and construction of the ship hull and niche areas, followed by operating profile of the ship and maintenance history.

1.6 These Guidelines describe recommended biofouling management practices, based on the life cycle of a ship as illustrated in Figure 1. Attention during initial ship design and construction may provide effective and sustainable means to reduce ship biofouling risks, supplemented by anti-fouling systems (AFS) for ships' submerged surfaces, including hull and niche areas.

1.7 The need for inspection and biofouling management may depend on the overall risk of biofouling on the hull and in niche areas, use of AFS and cleaning. By conducting a ship-specific assessment of risk profiles, locating potential areas with higher risk for biofouling, it will help to determine an optimized inspection regime. Cleaning is an important measure to remove biofouling from the hull and niche areas but when conducted in-water, it pose a risk for releasing invasive aquatic species into the water. Debris which is dislodged from the ship during the cleaning operation should therefore be collected. The Guidelines provides guidance for cleaning actions based on a biofouling rating number as well as providing recommendations on capture rates with an overall aim to minimize the risk of transfer of invasive aquatic species. Maintenance and ship recycling should also be conducted with sufficient preventative measures to avoid release of any invasive aquatic species into the water. When conducting biofouling management, potential release of harmful waste substances should also be considered.

1.8 In addition to the biofouling Guidelines, the following frameworks are relevant for minimizing the transfer of invasive aquatic species:

- The *International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004* (BWM Convention) aims to minimize the transfer of invasive aquatic species through ships' ballast water and sediments.
- The *International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001* (AFS Convention) addresses anti-fouling systems on ships and focuses on the prevention of adverse impacts from the use of anti-fouling systems and the biocides they may contain.

1.9 Biofouling management practices may also improve a ship's hydrodynamic performance and can be effective at enhancing energy efficiency and reducing air emissions from ships. This concept has been identified by the IMO in the *Guidance for the development of a ship energy efficiency management plan (SEEMP)* (MEPC.1/Circ.683). These Guidelines further support the *Initial IMO Strategy on Reduction of GHG Emissions from Ships* (resolution MEPC.304(72)).

1.10 The GEF-UNDP-IMO GloFouling Partnerships Project is part of the wider efforts by the International Maritime Organization (IMO), in collaboration with the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF), to protect marine ecosystems from the negative effects of invasive aquatic species. The aim of the GloFouling Partnerships Project is to build capacity in developing countries for implementing the IMO Biofouling Guidelines and other relevant Guidelines to minimize the transboundary introduction of invasive aquatic species, with additional benefits in the reduction of GHG emissions from global shipping.

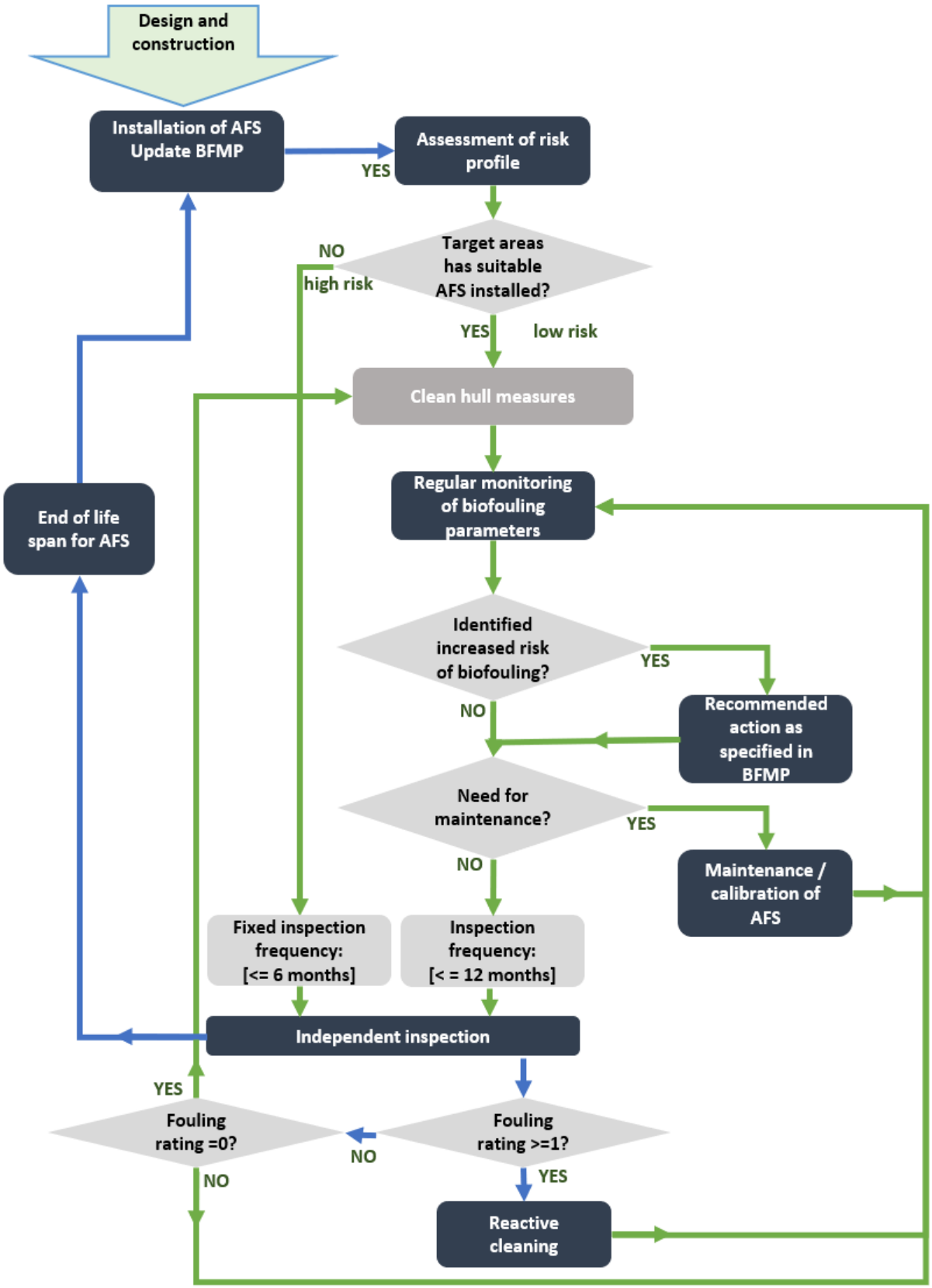

Figure 1 Flow chart visualizing the biofouling management life cycle for a ship in operation

2 DEFINITIONS

2.1. For the purposes of these Guidelines, the following definitions apply:

Anti-fouling system (AFS) means a coating, paint, surface treatment, surface, or device that is used on a ship to control or prevent attachment of unwanted organisms.

Anti-fouling coating (AFC) – a surface coating designed to prevent, repel or facilitate the detachment of biofouling from hull and niche areas that are typically or occasionally submerged.

Biofouling is the accumulation of aquatic organisms such as microorganisms, plants and animals on surfaces and structures immersed in or exposed to the aquatic environment. Biofouling can include pathogens in addition to microfouling and macrofouling (see definitions below).

Biofouling pressure means the biofouling accumulation rate, which differs regionally and seasonally. High biofouling pressure means the development of dense biofouling within a short period of time.

[Clean hull measures are used to maintain a clean hull by preventing attachment of microfouling by in-water cleaning at regular frequent intervals and includes hull grooming.]

Dry-dock cleaning refers to the cleaning of the submerged areas when the ship is out of water.

Fouling rating is the allocation of a number for a defined inspection area of the ship surface based on a visual assessment, including description of biofouling present and percentage of macrofouling coverage.

Independent inspection organisations are organisations [qualified to perform inspections in accordance with these guidelines] and determine level of biofouling and the condition of the AFS. [An independent organization is independent from the cleaning operator and ship operator.]

In-water cleaning is the removal of biofouling from a ship's hull and niche areas while in the water.

Invasive aquatic species are non-native species to a particular ecosystem which may pose threats to human, animal and plant life, economic and cultural activities and the aquatic environment.

Macrofouling is the attachment and subsequent growth of visible plants and animals on structures and ships exposed to water. Macrofouling is large, distinct multicellular individual or colonial organisms visible to the human eye such as barnacles, tubeworms, mussels, fronds/filaments of algae, bryozoans, sea squirts and other large attached, encrusting or mobile organisms.

Marine growth prevention system (MGPS) is an AFS used for the prevention of biofouling accumulation in niche areas or other surface areas, but may also include methods which apply surface treatments.

Member States means States that are Members of the International Maritime Organization.

Microfouling is biofouling caused by bacteria, fungi, microalgae, protozoans and other microscopic organisms, that creates a biofilm also called a slime layer.

Niche areas are submerged surface areas on a ship that are more susceptible to biofouling than the main hull due to structural complexity, different or variable hydrodynamic forces, susceptibility to AFC wear or damage, inadequate or no protection by AFS [or restricted accessibility for maintenance or inspection.]

Organization means the International Maritime Organization.

Port State authority means any official or organization authorized by the Government of a port State to verify the compliance and enforcement of standards and regulations relevant to the implementation of national and international shipping control measures.

Reactive cleaning is a corrective action during which biofouling is removed from a ship's hull and niche areas either in-water with capture or in drydock.

Ship means a vessel of any type whatsoever operating in the aquatic environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft, fixed or floating platforms, floating storage units (FSUs) and floating production storage and off-loading units (FPSOs).

States means coastal, port, flag or Member States as appropriate.

Waste substances are dissolved and particulate material that may be released from an AFS during normal operation, cleaning or maintenance, and may include biocides, metals, organic substances, pigments, microplastics or other contaminants.

3 APPLICATION

3.1. The Guidelines are intended to provide useful recommendations for measures to minimize biofouling for all types of ships. The Guidelines are directed to various stakeholders, such as ship designers, shipbuilders, anti-fouling paint manufacturers and suppliers, States, including environmental and regulatory agencies, classification societies, ship owners, ship operators, charterers, shipmasters, port authorities, ship cleaning and maintenance operators, independent inspection organizations, ship repair, dry-docking and recycling facilities, and any other interested parties.

3.2. Alternative procedures, methods or actions taken to meet the objectives of these Guidelines, which are not described, should be reported to the Organization by Members of the Organization and their representatives and be taken into account in future review of the Guidelines as appropriate.

3.3. A separate guidance document, based on these Guidelines, provides advice relevant to owners and/or operators of recreational craft less than 24 meters in length, using terminology appropriate for that sector (*Guidance for Minimizing the Transfer of Invasive Aquatic Species as Biofouling (Hull Fouling) for Recreational Craft*, MEPC.1/Circ.792).

3.4. The Guidelines may not be relevant to ships which operate only in the same waters in which the biofouling was accumulated. Although no risk of introducing invasive aquatic species, it is still relevant to avoid discharge of harmful waste substances from the AFC during cleaning, as outlined in paragraph 9.16 .2.

3.5. An inspection regime as defined in paragraphs 8.5 may not be relevant to a ship when idle for a longer period. To maintain the anti-fouling effect of an AFS, inspection and reactive cleaning may be needed before the ship is reactivated to reduce the risk of biofouling.

4 OBJECTIVES

4.1. The objective of these Guidelines is to minimize the transfer of invasive aquatic species through biofouling on ships.

4.2. Procedures, methods and actions taken in line with these Guidelines should safeguard the obligation under the United Nations Convention on the Law of the Sea (UNCLOS) article 194 to prevent, reduce and control pollution of the marine environment, and that such procedures, methods and actions taken do not interfere with the duty not to transfer directly or indirectly, damage or hazards from one area to another, or transform one type of pollution into another, ref. UNCLOS article 195.

4.3. The objective of these Guidelines is pursued by providing a globally consistent approach to stakeholders on the control and management of biofouling, which will contribute to minimize the risk of transferring invasive aquatic species from biofouling on ships. An additional effect of good biofouling management can be a reduction in emissions to air from ships, due to lower fuel demand in operation as a result from a clean hull.

5 DESIGN AND CONSTRUCTION

5.1. Recommendations for design and construction are mainly addressed to ship owners, ship designers and shipbuilders.

5.2. Initial ship design and construction offers the most comprehensive, effective and long-lasting means to minimize ship biofouling risks. In the design and construction of a ship, or when a ship is being significantly altered, the following items, not exhaustive, should be taken into consideration:

.1 Small niches and sheltered areas should be avoided as far as practical, e.g. flush mounting pipes in sea chests. Where not practical, these should be designed so that they may be easily accessed for inspection, cleaning and application of AFS like marine growth prevention systems (MGPS).

.2 Rounding and/or bevelling of corners, gratings and protrusions to promote more effective coverage of AFC and hinging of gratings to enable diver access.

.3 Providing the capacity to block off the sea chest and other areas, such as moon pools, floodable docks and other free flood spaces, for cleaning and treatment, if applicable and appropriate.

.4 Internal seawater cooling systems should be designed with a minimum number of bends and flanges. The design should be made of appropriate material to minimize biofouling, and be compatible with MGPS, if any. Dead ends, as can be found between different systems like cross-over piping between cooling and general service systems, should be avoided. Stand-by pumps and piping should be fully integrated into the systems to avoid stagnant water.

6 ANTI-FOULING SYSTEM INSTALLATION AND MAINTENANCE

6.1. Recommendations for AFS installation and maintenance are mainly addressed to ship owners, ship operators, shipbuilders, manufacturers and suppliers of AFC, MGPS, and drydocks.

6.2. AFS are effective means to minimize biofouling on ships' submerged surfaces, including the hull and niche areas.

6.3. Restrictions on the use of certain substances in the AFC are regulated by the AFS Convention.

Choosing an AFS

6.4. Different AFS are designed for different ship operating profiles and submerged surfaces on the ship and require different maintenance activities. Thus, it is essential that ship owners, ship operators and ship builders obtain appropriate technical advice. AFS manufacturers are best suited to provide advice to ensure an appropriate system is applied or installed. If an appropriate AFS is not applied, biofouling accumulation may increase. Some factors to consider when choosing an AFS include the following:

.1 **Ship design and construction;** Where possible and appropriate upon the recommendation of AFS manufacturers, targeted installation of AFS may be employed for different areas of the ship. AFS for the hull may include specific AFC, paint and/or surface treatment. Installation of any measures to maintain a clean hull should be in accordance with the recommendations from the AFC provider and should not damage the AFC. Different AFS are designed to optimize its performance for specific ship speeds. For niche areas, the selected AFS should be optimized for conditions of the niche area, e.g. an AFC may be recommended for use in combination with effective MGPS to minimize biofouling. AFC should be based on expected wear, abrasion and water flow rates.

.2 **Active ingredients of AFC;** Environmental impact assessment of the selected AFC with respect to the release of harmful substances should be considered. The limitations of an AFC to minimize biofouling should be known and may include operating profile, aquatic environment, ship design and lifecycle of AFC. Decision-makers should be aware of the limitations of each AFC and the recommended in-water cleaning methods in order to minimize potential environmental impacts and damage to the system. Depending on type of AFC (e.g., a self-polishing antifouling which allows the binder to chemically dissolve at a controlled rate, or harder coatings), various type of waste substances may be released when cleaning. Some waste substances may easily be captured but others are fine particles or dissolved substances that may be released into the water. Therefore, not all AFC types are designed for frequent cleaning. The AFC manufacturers should provide detailed information and guidance on potential release of waste substances. The impact on the effectiveness of a specific AFC from frequent cleaning should also be provided. The suppliers of cleaning methods/equipment should also provide guidance in documenting compatibility with AFC type.

.3 **Operating profile;** Patterns of use, operating routes, ship's activity level and periods of inactivity may influence the rate of biofouling accumulation and thus the effectiveness of the AFS. Inactivity may cause higher accumulation of biofouling. Fouling may attach more easily on slow-moving ships.

.4 **Aquatic environment;** Biofouling pressure differs between areas, depending on temperature, salinity and nutrient conditions. Biofouling grows more slowly, but is not prevented, in low temperature waters. Ships operating in ice conditions should consider special AFC. Different organisms grow in different salinity waters and, if a ship operates in all salinity ranges, the fouling system should target a wide range of organisms causing fouling. The benthic (seabed) environment should also be considered. Increasing depth of water and distance from shore may decrease susceptibility for biofouling. Additionally, higher content of nutrients in the water may increase algae blooms and susceptibility for biofouling.

.5 **Cleaning method;** Although cleaning system manufacturers are encouraged to find technological solutions that allow them to clean a wide variety of AFC, not all AFC can be cleaned by every cleaning system. When selecting the AFC, the available cleaning technologies and techniques and their suitability for the specific AFC should be considered. Therefore, the AFC manufacturers should provide detailed information and guidance on suitable cleaning methods, and potential effects on the effectiveness of a specific AFC. The choice of AFC should be compatible with the cleaning technologies available to ensure both minimum biofouling growth as well as reducing the risk of damage to the AFC and the potential release of harmful waste substances to the environment.

.6 **Maintenance;** The lifespan of an AFS should be considered in combination with dry-docking schedules. AFC lifespan and lifetime of MGPS (e.g. anodes) should exceed the period between drydocks.

.7 **Legal requirements:** In addition to the AFS Convention, any national or regional regulatory requirements, if relevant, should be considered in the selection of AFS. This may apply to release of chemicals from MGPS and the AFS.

Installing the AFS

6.5. Installing an AFS in hull and niche areas should be in accordance with manufacturer's guidance.

6.6. Niche areas are particularly susceptible to biofouling growth. Care should be taken in surface preparation and application of any AFC to ensure adequate adhesion and coating thickness. Particular attention should be paid to corners, edges, pipes, holding brackets and bars of grates. Corners, edges and welded joints should be smooth and coated with adequate coating thickness to optimize system effectiveness. Additionally, for such areas, it is recommended to apply a touch up to ensure film thickness or a higher-grade AFC.

6.7. A non-exhaustive list of recommended measures for installation of an AFS in niche areas are:

.1 **Sea chest;** Internal surfaces and inlet grates of sea chests should be protected by an AFS that is suitable for the flow conditions of the area over the grate and through the sea chest.

.2 **Bow and stern thrusters;** Free-flooding spaces which may exist around the thruster tunnel require special attention. The housings/recesses, and retractable fittings such as stabilizers and thruster bodies, should have an AFC of adequate thickness for optimal effectiveness.

.3 **Rudder hinges and stabilizer fin apertures;** Rudders and stabilizer fins should be moved through their full range of motion during the coating process to ensure that all surfaces are correctly coated to the specification of the AFC. Rudders, rudder fittings and the hull areas around them should also be adequately coated to withstand the increased wear rates experienced in these areas.

.4 **Propeller and shaft;** Propellers and immersed propeller shafts are generally not coated, but polished. Fouling release coatings or other suitable coatings may be applied where possible and appropriate to maintain efficiency.

.5 **Stern tube seal assemblies and the internal surfaces of rope guards;** Exposed sections of stern tube seal assemblies and the internal surfaces of rope guards should be carefully painted with AFC appropriate to the degree of water movement over and around these surfaces.

.6 **Cathodic protection (CP) anodes;** biofouling can be minimized in niche areas if anodes are flush-fitted to the hull, a rubber backing pad is inserted between the anode and the hull or the gap is caulked. Caulking the gap will make the seam or joint watertight. If not flush-fitted, the hull surface under the anode and the anode strap should be coated with an AFC suitable for low water flow to prevent biofouling accumulation. If anodes are attached by bolts recessed into the anode surface, the recess should be caulked to remove a potential niche.

.7 **Pitot tubes;** Where retractable pitot tubes are fitted, the housing should be internally coated with an AFC suitable for static conditions.

.8 **Sea inlet pipes and overboard discharges;** Pipe openings and accessible internal areas should be protected by an AFS as far as practicable. Any anti-corrosive or primer coating used should be appropriate for the specific pipe material and area requirements. Care should be taken in surface preparation and coating application to ensure good adhesion and coating thickness.

For details on recommended practices for MGPS, see Appendix 6.

6.8. Details for performance monitoring of the AFS should be included in the ship-specific biofouling management plan (BFMP) and be based on recommendations from the manufacturer of the AFS. Necessary measures to ensure that the AFS remains effective over the specified docking interval, plus any recommendations on how to return the AFS to optimal performance, should be included.

6.9. Manufacturers of AFS are also encouraged to provide information on appropriate cleaning methods, details of maintenance or upgrade protocols specific for the AFS and details

on inspection and repair to ensure the effectiveness of their products. Such details are encouraged to be included in the ship-specific BFMP.

Re-installing or repairing the AFS

6.10. Re-installing or repairing the AFC should be in accordance with manufacturer's guidance that includes measures for surface preparation to facilitate good adhesion and durability.

6.11. Positions of dry-docking blocks and supports should be varied at each dry-docking, or alternative arrangements made to ensure that areas under blocks are painted with an AFC, at least at alternate dry dockings. Where it is not possible to alternate the position of dry-docking support strips, these areas should be specially considered and managed by other means, e.g. the application of specialized coatings or procedures or measures for such areas based on the past arrangement of dry-docking support strips to shift their position step by step for each docking.

6.12. Re-installing or repairing the MGPS in niche areas should be in accordance with manufacturer's guidance.

6.13. When re-installing or repairing AFS in niche areas, the list of recommended items in paragraph 6.7 should be considered. A non- exhaustive list of some additional recommended measures for re-installation of an AFS in niche areas are:

.1 Bow and stern thrusters; – The body and area around bow, stern and any other thrusters prone to coating damage, should be routinely maintained during dry-dockings.

.2 Recesses within rudder hinges and behind stabilizer fins need to be carefully and effectively cleaned and re-coated during maintenance dry-dockings.

.3 Grates located in sea chests may require a major-refurbishment type of surface preparation at each dry-docking to ensure coating durability.

7 BIOFOULING RISK PROFILE AND MONITORING OF RISK PARAMETERS

7.1. Recommendations for assessing biofouling risk profiles and monitoring biofouling risk parameters during ship operation are mainly addressed to ship owners, ship operators and shipmasters, authorities and States.

7.2. The accumulation of biofouling is dependent on ship design, operational parameters, environmental conditions, as well as the AFS used. Biofouling does not accumulate homogenously on ships, and may typically be found in niche areas that are protected from high velocity water flow as the ship moves through the water or in areas which the AFS has been compromised or is not effective (e.g. damage to AFC). Therefore, it is recommended to apply various AFS types, suitable for different submerged areas, in order to have a lower risk for biofouling accumulation.

7.3. As presented in the flow chart in Figure 2, the risk profile of submerged hull and niche areas (target areas) should be identified and specified in the BFMP. A target area installed with an AFS, suitable for the ship specific operating profile and environmental conditions, will have a lower risk for biofouling accumulation. A niche area with no AFS installed will have

higher risk for biofouling accumulation. A ship-specific assessment will determine a biofouling inspection regime with recommended inspection intervals for high and low risk target area respectively.

7.4. During operation, various parameters may influence the accumulation of biofouling. If there is an operational change which deviates from the BFMP, or indications of failure or reduced efficacy of the AFS, the risk of biofouling accumulation may increase. As presented in Figure 1 an identified increased risk should lead to recommended actions involving either independent inspection or inspection by ship's crew, if qualified, to determine if the specific target area need cleaning and/or maintenance. It is the ship owner/operator responsibility to continuously monitor the biofouling risk parameters as presented in the flow chart in Figure 2. The monitoring may be conducted using a digital tool.

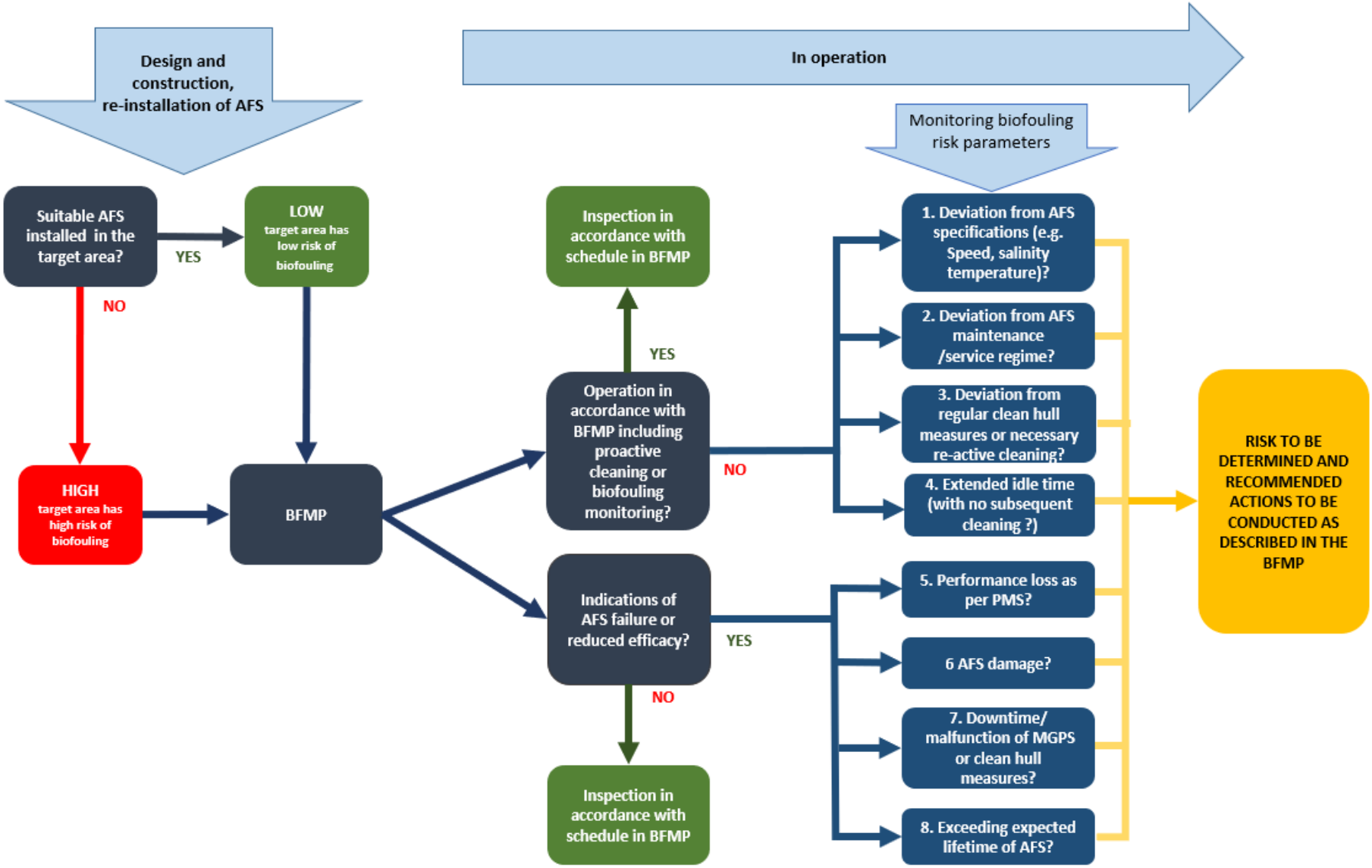

Figure 2 Flow chart visualizing the biofouling management risk profile and monitoring parameters

7.5. The ship-specific risk profile as well as the corresponding inspection and cleaning regime should be described in the BFMP. Description of the method to monitor the ships specific biofouling risk parameters (e.g. by using a digital tool) should be included in the BFMP. The BFMP should also include ships specific recommended actions to apply when the monitoring program identifies a higher risk of biofouling.

8 INSPECTION

8.1. Recommendations for inspection are mainly addressed to ship owners, ship operators, shipmasters, the charterer, the AFS manufacturer, port or local authorities, and independent inspection organizations.

8.2. The inspections should be carried out by independent inspection organizations [independent from the ship cleaning and maintenance operator and the ship owner].

8.3. In-water inspections should determine the level of biofouling of the hull and niche areas and the condition of the AFS. The inspection target areas should be sub-divided into appropriate sections as described in Appendix 5 and as listed in Tables A and B of Appendix 2. The fouling rating for each target area on the ship should be the highest rating identified of the inspected sub-divided areas, as recommended in Appendix 5.

8.4. The following should be investigated during the inspection:

1. Rating of the type and approximate extent of biofouling in accordance with the definitions in Table 2 below.
2. Condition of the AFS on the hull and in niche areas as described in paragraph 8.7 using definitions in Table B of Appendix 2.

Inspection frequency

8.5. Inspection frequency for in-water inspections during the in-service period of the vessel should be based on the ship-specific risk profile. For target areas with low risk for biofouling accumulation, the first inspection date should be within 12 months after drydock to confirm AFS systems are operating effectively. The inspection frequency for subsequent inspections may need to increase to confirm the continued effectiveness of aging AFS. For target areas with high risk for biofouling accumulation, a regime with shorter inspection frequency in accordance with Table 1 should apply.

Table 1 Suggested inspection frequencies for target areas based on risk profile

Risk profile for a target area	Recommended maximum interval between inspections
Low risk	[<=12 months (within 12 months after drydock, while subsequent inspections may need to increase)]
High risk	[0- 4 months (depending on the ship-specific assessment of relevant target area)]

Extent of biofouling and recommended actions

8.6. During an inspection, each inspection target area (as listed in the BFMP) should be allocated a fouling rating number according to the extent of fouling as defined in Table 2 below.

Depending on inspection result, the table includes recommended actions. When an inspection result does not trigger actions, the next scheduled inspection should ensure that the target inspection areas are extended, meaning more areas should be inspected in addition to identified high risk areas. See Appendix 5 for recommended practices on inspection.

Table 2 . Rating scale to assess the extent of fouling on inspection target area

Rating	Description	Macrofouling cover of area inspected (visual estimate)	Recommended cleaning action
0	**No fouling**. Surface entirely clean. No visible biofouling on surfaces.	-	[Measures to maintain a clean hull may be recommended if compatible with the AFC as further specified in 6.4.2]
1	**Light microfouling**. Submerged areas partially covered in light microfouling. Metal and painted surface visible beneath the fouling.	-	Reactive cleaning with capture is recommended as further specified in paragraph 9.13 and paragraph 9.16.
2	**Heavy microfouling**. Metal and painted surfaces obscured. Submerged areas partially or entirely covered in microfouling	-	
3	**Light macrofouling**. Presence of heavy microfouling and multiple macrofouling patches. Fouling species cannot be easily wiped off by hand.	1–15% of surface	
4	**Medium macrofouling**. Presence of heavy microfouling and multiple macrofouling patches.	16-40% of surface	Reactive cleaning with capture is recommended as further specified in paragraph 9.13 and paragraph 9.16. May need shorter intervals between the next inspections
5	**Heavy macrofouling**. Large patches or submerged areas entirely covered in macrofouling.	41–100% of surface	

Condition of the AFS

8.7. The condition of the AFS on the hull and in niche areas should be observed during the inspection and reported. Recommended action and relevant procedures for inspection of the AFS are described in Table B of Appendix 2. Any failure or indications of reduced efficacy to any AFS, especially such that has a direct impact on the ability of the system to control biofouling, may lead to higher biofouling risk rating for the specific area, and/or reduced inspection frequencies in accordance with paragraph 8.5.

Inspection Report

8.8. An inspection report should be prepared and maintained on board at least until the next drydocking. Appendix 2 outlines the minimum amount of information that should be included in an inspection report. Digital tools may be applied for reporting.

8.9. A copy of the inspection report or similar outcome in a digital tool should be available on board and listed/linked in the BFRB. For details on reporting on biofouling levels and AFS condition inspections, see Appendix 2 Tables A and B.

9 CLEANING AND MAINTENANCE

9.1. Recommendations for cleaning are mainly addressed to ship owners, ship operators, shipmasters, ship cleaning and maintenance operators, authorities, drydocks and ship recycling facilities.

9.2. Cleaning with capture should be applied to hull and niche areas when an inspection provides evidence of biofouling, as specified in paragraph 8.6 and Table 2. Cleaning activities can be conducted in dry-dock, in-water including on route, in harbor or at anchorage.

9.3. Cleaning may physically damage some AFC, shorten coating service lifetime and release harmful waste substances into the environment. These aspects should be considered when choosing a cleaning procedure.

9.4. [Testing of a cleaning devices could be helpful to understand the cleaning performance, capture rates, or any release of waste substance as well as improving knowledge concerning the prevention of release of viable fragments, spores and other parts of alien species that have the potential to settle, grow and reproduce in outer waters.]

[Procedures to maintain a clean hull

9.5. Measures to maintain a clean hull may include gentle wiping or use of hydrodynamic forces to maintain a clean hull and avoid attachment of early stages of microfouling. Such measures are not an alternative to reactive cleaning but may be a supplement to allow longer intervals between re-active cleaning in relevant submerged area on hull and niche areas.

9.6. Clean hull measures can be carried out without capture if the fouling rating in the relevant hull or niche area is 0 in accordance with Table 2 in chapter 8.

9.7. The technology used to maintain a clean hull should ensure that;

.1 it is compatible with the AFC in order to avoid erosion of the AFC;
.2 the cleaning operation is safe for personnel involved in the activity;
.3 it does not increase the release of waste substances; and
.4 it avoids cleaning of fouling rating >=1.

9.8. Operators undertaking clean hull measures should be aware of any local regulations or requirements.

9.9. Taking note of the operational situation, clean hull measures should be carried out at regular intervals of sufficient frequency to avoid attachment of microfouling. The clean hull measures should remove any non-visible pre-stage to light microfouling and avoid transfer of invasive species.

9.10. Procedures for clean hull measures and frequency should be described the BFMP. All clean hull measures, including determination of biofouling level prior to the cleaning, should be entered in the biofouling record book (BFRB). Digital tools may be applied for documentation and the activities of clean hull measures and should be recorded in the biofouling record book (BFRB).]

Procedures for reactive cleaning

9.11. Reactive cleaning systems physically remove micro- and macrofouling from the hull and niche areas. There are various reactive cleaning methods available and more under development as presented in Appendix 6.

9.12. Reactive cleaning should be conducted based on the inspection results and recommended action as outlined in Table 2 of paragraph 8.6.

9.13. The reactive cleaning technology should ensure that;

.1 it is compatible with the AFC in order to avoid damage of the AFC;
.2 the cleaning operation is safe for personnel involved in the activity;
.3 the cleaning should be conducted with the aim of removing any visible macrofouling to achieve a biofouling rating ≤1 for the cleaned target area in accordance with Table 2.
.4 biofouling and waste are captured in accordance with 9.16 when reactive cleaning performed in-water; and
.5 biofouling and waste are collected when reactive cleaning performed in dry dock.

9.14. Biofouling management in niche areas should include;

.1 maintenance of any MGPS installed to ensure they operate effectively to prevent accumulation of biofouling in relevant niche areas;
.2 regularly polish of uncoated propellers to maintain operational efficiency and minimize macrofouling accumulation;
.3 appropriate treatment of internal seawater cooling systems and discharge of any treated water in accordance with applicable regulations; and
.4 minimize use of any soap, cleaner, or detergent used on surfaces and ensure they are toxic- and phosphate free and biodegradable.

9.15. Operators undertaking in-water reactive cleaning should be aware of any regulations or requirements. Regulations regarding the discharge of biofouling and waste substances into the marine environment and the location of sensitive areas (such as marine protected areas) may be relevant.

9.16. When in-water reactive cleaning is conducted, every effort should be made to capture any debris which is dislodged from the ship during the operation. To optimize capture rates, the cleaning and capture technology should be designed for the area to clean (i.e flat or curved surfaces). Capture of biofouling and waste substances released from AFS or relevant technology during reactive cleaning operations should meet the following measurable capture rates:

.1 Cleaning and capture methods should not lead to increase of concentrations of TSS in the surrounding ambient water in the location where the cleaning takes place during the same time period;
.2 cleaning and capture methods should not lead to significant increase of concentrations of dissolved [biocides], [microplastic] from AFS, if relevant, in the surrounding ambient water in the location where the cleaning takes place during the same time period;

.3 the cleaning operation should collect at least [99%] [97%] [90%] (by mass) of the captured debris before any discharge to sea;
.4 the cleaning operation should collect at least [99%] [97%] [90%] of waste particulate material, including organisms, in size ≥10 µm (in equivalent spherical diameter) of the captured debris before any discharge to sea; and
.5 [the cleaning systems should not release any visual objects to sea or introduce discoloration of the surrounding water.]

9.17. Captured biological waste and waste substances should be disposed of and treated in a safe and environmentally sound manner, in accordance with local requirements.

9.18. A report of the cleaning should be prepared by the operators undertaking reactive cleaning. The report should have the content as described in Appendix 2 and describe the cleaning outcome of the target areas. Digital tools may be applied for reporting.

9.19. A copy of the cleaning report or similar outcome in a digital tool should be available on board and the activity entered in the BFRB.

Procedures for recycling facilities

9.20. Ship recycling facilities should adopt measures (consistent with applicable national and local laws and regulations) to ensure that viable biofouling organisms or waste substances, are not released into the local aquatic environment as described in paragraphs 9.13 and 9.14.

9.21. Ship recycling facilities should develop a plan to minimize release of biofouling organisms and/or harmful waste substances. If relevant, it is recommended that hull and niche areas are cleaned prior to recycling to avoid release of viable biofouling organisms or waste substances.

10 BIOFOULING MANAGEMENT PLAN

10.1. It is recommended that every ship has a ship-specific BFMP under the responsibility of ship owners, ship operators and shipmasters. A BFMP should include input from ship designers, shipbuilders, shipowners, AFC and MGPS manufacturers, recognized organizations and suppliers.

10.2. An effective BFMP should contribute to the aim of maintaining a recommended fouling rating below 1, as described in chapter 8.

10.3. The ship-specific BFMP should include, but not necessarily be limited to the following:

.1 The BFMP should identify the officer, or the position (e.g. chief engineer) responsible for the BFMP.
.2 Details of the AFS installed and where.
.3 Details of the recommended operating conditions which are suitable for the selected AFS to avoid deterioration of AFC, including recommended conditions such as temperature, salinity, speed, etc.
.4 Details of expected AFC efficacy throughout AFC lifetime including the need for inspection or maintenance, if relevant.
.5 Regime for clean hull measures, if any.
.6 Details of risk profiles per target area (hull and niche areas).
.7 Schedule for independent inspections of low and high risk profile target areas.

.8 Procedures for reactive cleaning actions that should be performed if triggered by inspection results.
.9 Description of monitoring on biofouling risk parameters and proposed corrective actions.
.10 Description of when the biofouling risk parameters should trigger a recommended action.
.11 Description of recommended actions (i.e. either independent inspection or inspection by ship's crew, cleaning and/or maintenance).
.12 Contingency measures in case of unforeseen biofouling events.
.13 Regime for repairs, maintenance and renewal of AFS, when relevant, in accordance with the manufacturer's instructions.
.14 Process for monitoring and maintenance as per the manufacturer's instructions of marine growth prevention systems (MGPSs) to ensure their effectiveness in minimizing biofouling.
.15 Regime for maintenance of any other AFS, if any.
.16 Details of the documentation/reports required to document biofouling activities.

Continuous improvements

10.4. Information should be gathered to plan and facilitate efficient and sustainable biofouling management, allowing the evaluation and comparison of the cost-effectiveness of alternative strategies. The optimal solution is case-specific and should be considered in the light of several aspects.

10.5. Monitoring of the hull and the risk parameters as identified in the risk assessment, may determine a risk for biofouling to be higher than predicted in the BFMP and therefore trigger more frequent inspections.

10.6. Inspection results may be shared in agreement with stakeholders involved if they are relevant for improvement purposes. To increase the efficiency of biofouling management and inspections, independent inspection organizations are encouraged to share inspection results with AFS manufacturers.

10.7. The effectiveness of the management actions in place should be reviewed following inspections and cleaning. The BFMP should be updated if the management actions in place are ineffective or deficient. Efficacy of the following items should be evaluated:

.1 Ability to minimize biofouling by use of clean hull measures methods.
.2 Biofouling inspections schedule.
.3 Ability to minimize biofouling by marine growth prevention system (MGPS).
.4 AFS performance.
.5 Outcome of reactive biofouling management procedures:

- efficacy of the biofouling removal (i.e. no areas are missed).
- accessibility for reactive cleaning in niche areas

10.8. Guidance for the development of a BFMP is outlined in Appendix 3 of these Guidelines.

11 BIOFOULING RECORD BOOK

11.1. The overall record keeping of ship-specific biofouling management activities in a biofouling record book (BFRB) is the responsibility of ship owners, ship operators and/or shipmasters. The ship-specific BFRB should include information on biofouling management actions with input from AFS manufacturers and suppliers, ship cleaning and maintenance operators, independent inspection organizations, ship repair and dry-docking facilities when relevant.

11.2. It is recommended that the BFRB be retained on board for the life of the ship. The book should record details and reports of all inspection and maintenance activities to be undertaken for all hull and niche areas. The BFRB may be maintained physically or electronically, and could be a stand-alone document, or integrated in part, or fully, into the existing ships' operational and procedural manuals and/or planned maintenance system.

11.3. The BFRB should assist the shipowner and operator to evaluate the efficacy of the specific AFS and biofouling management measures on the ship.

11.4. All biofouling management activities should be recorded in a BFRB, including the following:

.1 The date and location of preventive activities, like clean hull measures.
.2 Details of repair and maintenance to the AFS including date, location and areas of the ship affected, including the percentage of the ship that was re-coated with AFC This is in addition to recordings in the International Anti-fouling System Certificate.
.3 Details of the MGPS, including date, location and areas of the ship affected.
.4 The initial date, final date, extension in hours/days and location of in-water inspections, including the inspection report.

.5 The initial date, final date, extension in hours/days and location of reactive cleaning (in-water or in dry-dock), including a cleaning report.
.6 Details of when the ship has been operating outside its normal operating profile including any details of when the ship was laid-up or inactive for extended periods of time.

11.5. Guidance for the development of a BFRB is outlined in Appendix 4 of these Guidelines.

12 DISSEMINATION OF INFORMATION

12.1. States are encouraged to provide information on the location of and the terms of use for clean hull measures, inspection, reactive cleaning services and facilities to comply with these Guidelines. States requiring inspection or cleaning prior to arrival in their territory should inform the Organization.

12.2. States are also encouraged to provide technical and research information to the Organization, including any studies on the impact and control of invasive aquatic species in ships' biofouling, information on local biofouling pressure, databases on regional biofouling management options, tools for the choice of AFS, and on the efficacy and practicality of in-water cleaning technologies, risk assessment tools and inspection reporting tools.

12.3. State authorities should provide ships with timely, clear and concise information on biofouling management measures and cleaning requirements that are being applied to shipping and ensure these are widely distributed. Shipowners and operators should endeavor to become familiar with all requirements related to biofouling by requesting such information from their port or shipping agents or competent authorities (i.e. State authorities).

12.4. Organizations or shipping agents representing shipowners and operators should be familiar with the requirements of State authorities with respect to biofouling cleaning and management procedures, including information that will be needed to obtain entry clearance. Verification and detailed information concerning State requirements should be obtained by the ship prior to arrival.

12.5. To monitor the effectiveness of these Guidelines as part of the evaluation process, States are encouraged to provide the Organization with records describing reasons why ships could not apply these Guidelines, e.g. design, construction or operation of a ship, particularly from the viewpoint of ships' safety, or lack of information concerning the Guidelines.

13 TRAINING AND EDUCATION

13.1. Training for ships' masters and crew, in-water cleaning or maintenance facility operators and those surveying or inspecting ships as appropriate should include instructions on the application of biofouling cleaning and management procedures, based upon the information contained in these Guidelines. Instruction should also be provided on the following:

.1 Maintenance of appropriate records and logs.
.2 Impacts of invasive aquatic species from ships' biofouling.
.3 Benefits to the ship of managing biofouling and the threats posed by not applying management procedures.
.4 Biofouling management measures and associated safety procedures.
.5 Relevant health and safety issues.

13.2. States and industry organizations should ensure that relevant marine training organizations are aware of these Guidelines and include them in their syllabuses as appropriate.

14 OTHER MEASURES

14.1. To the extent practical, States and port authorities should aim to ensure smooth flow of ships going in and out of their ports to avoid ships waiting offshore, so that AFS can operate as effectively as possible.

14.2. States may apply other measures to ships within their jurisdiction for the purpose of providing additional protection for their marine environment, or in emergency situations. When managing emergency situations for biofouling, States may find the guidance document for ballast water emergency situations (BWM.2/Circ.17, as may be amended) also relevant to biofouling management.

14.3. States should consider these Guidelines when developing other measures and/or restrictions for managing ships' biofouling.

14.4. Where other measures are being applied, States should notify the Organization of the specific requirements, with supporting documentation, for dissemination to other States and non-governmental agencies where appropriate.

14.5. The application of other measures by States should not place the safety of the ship and crew at risk.

LIST OF APPENDICES

APPENDIX 0 ABBREVIATIONS

[to be included if needed]

AFS	Anti-fouling system
AFC	Anti-fouling coating
BFMP	Biofouling management plan
BFRB	Biofouling record book
CP	Cathodic protection
IMO	International Maritime Organization
MGPS	Marine growth prevention system
PMS	Performance monitoring system

APPENDIX 1 ASSESSMENT OF BIOFOULING RISK

1 Introduction

The Guidelines recommend taking a proactive approach to biofouling through assessment of biofouling risk profiles for hull and niche areas and by monitoring various risk parameters during operation. An assigned risk profile should be ship-specific as well as the monitoring points for the ship-specific operation.

Monitoring various risk parameters during operation will lead to a holistic approach to BFM in line with a risk-based approach.

2 Identification of risk areas

Typical niche areas on the hull are indicated on the diagram in Figure 1, but other niche areas may be relevant.

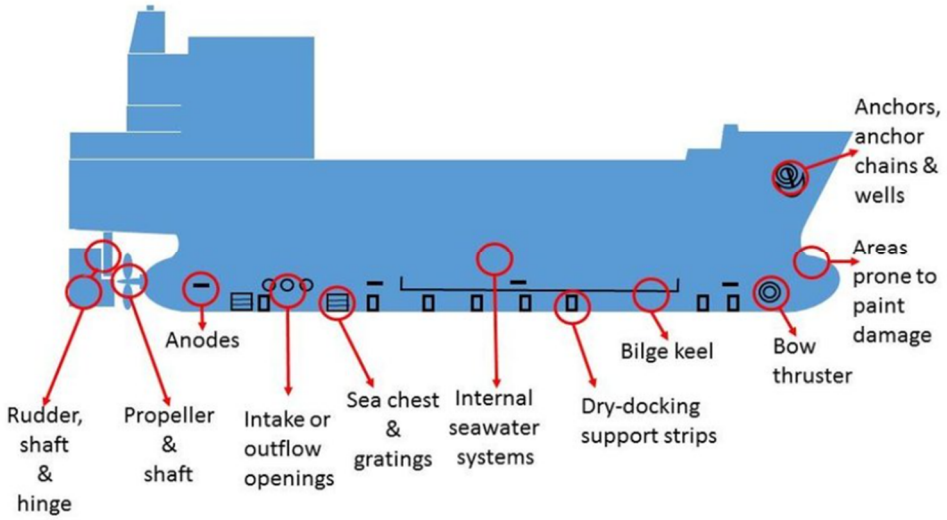

Figure 1 Hull with typical niche areas susceptible to biofouling (source: *Eugene, Conduct of land-based biofouling surveys for domestic vessels)*

3 Relevant parameters to be considered in the risk assessment

A ship-specific assessment should be established by dividing the ship into relevant target areas and determining a risk profile for each target area . The outcome is a compilation of risk profiles for each target area which should be included in the BFMP. For example, if a target area has no AFS installed, that area would typically have a high-risk rating. If all target areas have an AFS installed which is compatible with the ships operating profile, the ship has an overall low risk profile.

Based on the risk profile, an inspection regime should be determined and described in the BFMP. If the assessment determines that a target area has high risk for biofouling accumulation, an inspection regime with short intervals between inspections is recommended for that target area. Further, the target areas with a low risk profile may follow the inspection regime with longer intervals as specified in chapter 8 of the Guidelines.

The risk profile indicates the possibility of accumulating biofouling and increases as a function of biofouling pressure versus biofouling protection over time. The biofouling risk parameters given in Figure 2 of chapter 8 should be monitored as the risk of biofouling accumulation may increase over time. When higher risk is identified, recommended actions in form of inspection, reactive cleaning and or maintenance of AFS should be performed as described in the BFMP.

In accordance with Figure 2 of chapter 7, a hull performance monitoring system can be used to assess the changes in the propulsion power and fuel consumption of the ship. Such changes may indicate a degradation of hull or propeller condition due to biofouling.

The results from the hull performance monitoring may indicate biofouling growth on the hull and propeller, however, growth in niche areas will not necessarily be detected with this monitoring method.

Digital tools may be applied for monitoring of biofouling risk parameters. Monitoring of parameters should be as thorough as practicable. A description of determination of risk based on various biofouling risk parameters are given in Table A below.

Table A: Risk profile description

	Examples of biofouling risk parameters	Description of parameter
1	**Deviation from AFS specifications (e.g speed, salinity temperature**	An AFS/AFC can typically work well within a specific range of operating parameters. The relevant parameters and acceptable ranges for each parameter should be described in the manufacturers specification and included in the BFMP. Specifications typically include operation routes, ship activity level, speed, water salinity and temperatures and cleaning requirements. Specifications may vary depending on the technology of the AFS used. Ship operations should be in accordance with the recommendations from the AFC manufacturer. Deviation from the specification of the ship's AFC may increase the deterioration of the AFC or reduce its efficacy and change the biofouling risk. Incidental deviations must be evaluated for potential biofouling impact. Continuous or regular deviations, or deviations not rectified, would lead to an elevated risk profile and more frequent inspection regime.
2	**Deviation from AFS maintenance/service regime**	Regular maintenance and service, (e.g calibration or adjustment of treatment dosages for a MGPS), may be necessary actions for proper protection by the AFS. If the maintenance and service time is exceeded, as specified by manufacturer, the risk profile is elevated. For maintenance of AFC, see item 7. Missing maintenance and/or service should be evaluated for potential biofouling impact.
3	**Deviation from regular clean hull measures or necessary re-active cleaning**	When clean hull measures is part of the ship specific BFM, deviation from regular use as specified in the BFMP may lead to increased risk of biofouling growth onto relevant areas. Lack of reactive cleaning when inspection has determined cleaning is necessary, will lead to increased risk for further biofouling growth.
4	**Extended ship idle time**	Biofouling accumulation starts immediately when a ship is idle. To avoid risk of biofouling, the operating profile should only allow short periods in port or at anchorage or at least not exceed the recommendation by the AFS manufacturer. Acceptable idle time should be specified in the ship's BFMP. Idle time is often defined in charter party contracts and typically ranges between 18 to 30 days For idle time longer than specified in the BFMP, the risk profile changes. If the number of consecutive idle days is still within what is specified as acceptable as per AFS supplier's guarantee and/or idling takes place in area far from shore (>200 nm and >200 m depth), the risk may still be considered low. If the number of consecutive idle days is beyond what is specified as acceptable as per AFS supplier's guarantee, the risk may be considered very high.
5	**Performance loss as per PMS**	Performance monitoring of fuel consumption may indicate a possible biofouling accumulation on the hull. Performance monitoring is mainly for hull monitoring (not niche areas) and may include the following methods: .1 Sensors and collecting high frequency data. .2 Semi-automatic or manual calculations using data collected from ship's crew (e.g. noon reports). .3 Speed trials and comparing the performance data with previous speed trial reports. Note that PMS is often a lagging indicator and may depend on many factors, therefore additional measures may be necessary before it can be used to determine the risk profile. According to ISO 19030-2, a speed loss between 1% and 3% or increased fuel consumption of 3-9% may indicate light biofouling while a speed loss > 3% or fuel consumption increase by >9% may indicate higher biofouling risk.

6	**AFS damage**	Failure caused by mechanical damage to the AFS may result in higher risk of biofouling in the areas affected, if not rectified. The impact from the damage should be evaluated for potential biofouling.
7	**Downtime/malfunction of MGPS, clean hull measures or other AFS**	Observed downtime of an MGPS, clean hull measures or other AFS have a direct impact on risk of biofouling accumulation. The impact on risk profile for the area impacted will be affected depending on duration of malfunction. Reduced operation time of clean hull measures, i.e longer intervals between cleaning than specified in the BFMP, is defined as downtime and may increase biofouling accumulation in those areas where it is not applied as specified in the BFMP. The impact on risk profile for the area impacted will be affected depending on duration of malfunction and the trading conditions during that time. If clean hull measures without capture is irregular, ships should be aware of possible macrofouling accumulation and take actions to avoid spread of macrofouling. If microfouling growth exceeds fouling rating 1, cleaning with capture is recommended.
8	**Exceeding expected lifetime of AFS**	Once an AFS has exceeded its lifetime, as specified by the manufacturer, the biofouling risk profile is elevated. Additionally, the efficacy of the AFS may be reduced as it approaches the end of its lifetime. The performance of the AFS, and any necessary change in maintenance or inspection schedule, as given by the AFS manufacturer, should be specified in the BFMP.

APPENDIX 2 INSPECTION AND REACTIVE CLEANING REPORT

1 Introduction

The Guidelines recommend that a report should be prepared after an inspection and/or reactive cleaning operation. The report should record the details of the biofouling management actions undertaken on the ship. The inspection report should be prepared by an independent inspection organization. The cleaning report should be prepared by either the cleaning operators or the independent inspection organization as part of a combined cleaning and inspection report. Digital tools may be applied for the reporting and/or assessment of results. The conclusion of the reports should be recorded in or linked to the biofouling record book (BFRB) including reference to the detailed report/assessment.

2 Entries in the report after a biofouling inspection

The following information should be recorded in the inspection report:

- Ship particulars:
  - ship name
  - IMO number
- Date and place of inspection
- Name of inspection/cleaning company
- List of all inspected hull and niche areas
- Inspection equipment used (i.e list of divers/ROV operators participating in the operation
- Inspection conditions (i,e duration, estimated visibility underwater)
- Signature of authorized person of the inspection/cleaning company
- Inspection/cleaning start and end times
- Results:
  - Type of biofouling in accordance with the rating in Table 2 of chapter 8 of these Guidelines
  - Quantitative assessments of biofouling cover of area inspected (i.e. estimates of percent cover) in accordance with Table 2 of chapter 8 of these Guidelines
- AFC condition
  - The condition of the AFC should be observed during the inspection and reported. The condition is recommended to be categorized in accordance with Table B
- Photos/videos
  - Photos and videos submitted or used in a digital assessment tool as evidence of hull fouling as described in Appendix 5

SAMPLE OF INSPECTION REPORT

Name of ship: .....

IMO number: .....

Date: .....

Port: ……..

Inspection organisation: …….

Conditions: …….

Inspection equipment used: …….

Quantitative assessment of biofouling cover is summarised in Table A (in accordance with the rating in Table A in chapter 8 of these Guidelines)

Table A: Quantitative assessment of biofouling cover

For each transect and niche area surveyed, the mode of the fouling rating (most frequent rating) and the range (lowest and highest rating) should be recorded. An average should not be used. If more than one of the same type of area is assessed, these should be recorded separately and each be given their own fouling rating.

Target areas examples	**Fouling rating**					
	0	1	2	3	4	5
Bow						
Bow thruster						
Hull below the waterline:						
Port vertical side						
1 m wide belt						
1 m wide belt of sub-section X						
1 m wide belt of sub-section X						
Starboard vertical side						
1 m wide belt						
1 m wide belt of sub-section X						
1 m wide belt of sub-section X						

Flat bottom front						
1 m wide belt						
1 m wide belt of sub-section X						
Flat bottom mid						
1 m wide belt						
1 m wide belt of sub-section X						
Flat bottom aft						
1 m wide belt						
1 m wide belt of sub-section X						
Bilge keels						
Sea chest gratings						
Location 1						
Location 2						
Stern						
Propeller and its shaft						
Rudder and rudder shaft						
Discharge pipes						
Rope guards						
Sounders/instruments						
Sacrificial anodes						
Internal seawater systems						
…..						
…..						

A target area should be assigned a fouling rating equal to the highest rated 1 m^2 identified along the sub-divided areas.

The inspection should be as comprehensive as practicable. The more sub-divided areas that are inspected, the greater the certainty that the biofouling for the target area is realistic. It is recommended that the identified niche areas should be in accordance with the BFMP.

The condition of the anti-fouling coating (AFC) should be observed during the inspection and reported. The condition is recommended to be categorized in accordance with Table B. If the condition AFC could only be thoroughly assessed after reactive cleaning, Table B should be part of the cleaning report.

Table B: The condition of the AFC

AFC condition								
Target areas examples	**Intact**	**Adhesion between a coating and a metallic surface**	**Blistering in coating**	**Cracks in the coatings**	**Cold flow resulting in irregular coating thickness**	**Delamination / peeling / detachment between coatings**	**Polishing of coating during the ship's operation**	**Grounding / general damage to coating**
Bow								
Bow thruster								
Hull below the waterline:								
Port Vertical Side								
sub-section X								
Starboard Vertical Side								
sub-section X								
Flat bottom Front								
sub-section X								
Flat bottom Mid								
sub-section X								
Flat bottom AFT								
sub-section X								
Bilge keels								
Sea chest gratings								
Location X								
Location X								
Stern								
Propeller and its shaft								
Rudder and rudder shaft								
Discharge pipes								
Rope guards								
Sounders/instruments								
Sacrificial anodes								
…								
…								

Comments: ……..……

Reference to supporting photos/videos for fouling inspection and assessment of AFC: ……..……

Signature of inspection organization: ……..……...……

3 Entries in the report after biofouling management (reactive cleaning)

The following information should be recorded in the cleaning report:

- Ship particulars:
  - ship name
  - IMO number
- Date: .....
- Port: …….
- Cleaning company: …….
- Conditions: …….
- Cleaning equipment used: …….
- Locations cleaned/treated
  - All hull and niche areas specified and documented in the report
  - Type of biofouling after reactive cleaning (in accordance with the rating in Table 2 of chapter 8 of these Guidelines)
  - Quantitative assessments of biofouling cover after cleaning (in accordance with Table 2 of chapter 8 of these Guidelines)
- AFC condition (unless assessed during inspection)
  - The condition of the AFC should be observed during the cleaning activity and reported using the conditions as categorized in Table B
- Photos/videos
  - Photos and videos submitted or used in a digital assessment tool as evidence of hull cleaning are described in Appendix 5
- Capture
  - Supporting evidence that dislodged material (by mass) has been captured as described in chapter 9
    (Reference to equipment specification and validation test report may be sufficient)
- Treatment and/or disposal of waste

Evidence of delivery to waste management facility(ies) should be attached to the cleaning report. The biofouling waste should be disposed of and/or treated in a safe and environmentally sound manner, in accordance with local regulations, and ensure that the main objective of the Guidelines, to minimize the spread of invasive aquatic species, is safeguarded.

SAMPLE OF A BIOFOULING CLEANING REPORT

Name of ship: .....

IMO number: .....

Date: .....

Port: ……..

Cleaning company: …….

Conditions: ……

Technology used for reactive cleaning (i.e. manual in-water cleaning):
……
…….

Table C: Summary of the operations

Target areas examples	New fouling rating after performed cleaning		
	0	1	2
Bow			
Bow thruster			
Hull below the waterline:			
Port vertical side			
sub-section X			
sub-section X			
sub-section X			
Starboard vertical side			
sub-section X			
sub-section X			
sub-section X			
Flat bottom front			
sub-section X			
sub-section X			
Flat bottom mid			
sub-section X			
sub-section X			
Flat bottom aft			
sub-section X			
sub-section X			
Bilge keels			

Sea chest gratings			
Location 1			
Location 2			
Stern			
Propeller and its shaft			
Rudder and rudder shaft			
Discharge pipes			
Rope guards			
Sounders/instruments			
Sacrificial anodes			
Internal seawater systems			
….			
….			
Overall fouling rating of ship			

Description of activity and reference to supporting evidence (photos/videos):

Description of capture and reference to supporting evidence:

Description of treatment and/or biofouling waste disposal with supporting evidence (e.g. receipts):

Comments:

Signature of cleaning organization: ……..……...……

APPENDIX 3 BIOFOULING MANAGEMENT PLAN (BFMP)

INTRODUCTION

The following information should be considered when developing a BFMP (the Plan). It is important that the Plan is specific to each ship.

The Plan may be a stand-alone document or integrated in part or full in the ships' operational and procedures manuals and/or planned maintenance systems. The BFMP may be electronic and/or based on a digital tool.

The Plan should be written taking into account the *20xx Guidelines for the Control and Management of Ship's Biofouling to Minimize the Transfer of Invasive Aquatic Species*, resolution MEPC.xxx, adopted on xxx.

Biofouling on ships can be a significant vector for the transfer of invasive aquatic species. The purpose of the Plan is to assist the ship crew in conducting biofouling management. Release of biofouling organisms may establish as invasive aquatic species and pose threats to human economic and cultural activities and the aquatic environment.

Biofouling management practices may also improve a ship's hydrodynamic performance and can be effective at enhancing energy efficiency, hence reducing air emissions from ships as well as fuel costs.

The Plan should be readily available to any port State authority for viewing on request and should be in English and translated into other working language of the crew.

SHIP PARTICULARS

At least the following details should be included:

- Ship's name.
- Flag.
- Port of registry.
- Gross tonnage.
- IMO number
- Class society.
- Overall length.
- Beam.
- Ship type.
- International call sign and Maritime Mobile Service Identity (MMSI).

INDEX

A table of contents should be included.

PURPOSE

The purpose of the Plan is to outline measures for the control and management of ships' biofouling in accordance with the *20xx Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Aquatic Species* (the Guidelines). The Plan provides operational guidance for the planning and actions required for ships' biofouling management.

THE ANTI-FOULING SYSTEM AND MAINTENANCE SYSTEMS

The Plan should describe the anti-fouling systems (AFS) in place for different parts of the ship, including:

- type(s) of anti-fouling coating (AFC) and where applied;
- type(s) and location of MGPSs in niche areas;
- details of where AFS are not applied or installed;
- manufacturer and product names of all AFC or MGPS products used in the AFS; and
- AFS specifications, including but not limited to:
  - AFS characteristics as specified in the IAFSC record
  - dosing and frequency for MGPSs
  - expected effective life before maintenance is required for AFS, or chemical substance need to be re-filled for MGPS
  - operating conditions required for coatings to be effective (e.g. temperature, salinity, speed, etc.)
  - acceptable idle time and/or recommended actions during idle time for the ship’s AFS to be effective
  - reactive cleaning requirements and recommended methods
  - any other specifications relevant for AFS performance.
- clean hull measures, if applied. Maintenance of the efficiency of the AFS, including clean hull measures may reduce the overall risk in areas where applied on the ship. Specific advice about clean hull measures should be described if applied. This would include information such as when, for how long and any maintenance required for the activity related to clean hull measures. Procedures and advice for actions should also be included for cases where clean hull measures cannot be conducted in accordance with the Plan.

Table 1 provides an example of details to be included for the AFS.

Table 1 Anti-fouling protection system specifications

AFS used on this ship	Area/ location applied (refer to Table 2)	Manufacturer and product name	Expected effective life	Details		
				Thickness	Requirement for cleaning	Operating profile for AFS to be effective
Coating:						
Coating A						
Coating B						
				Details on treatment, if relevant		**Frequency of use**
MGPS:						
MGPS type A						
MGPS type B						
Clean hull measures/other maintenance of AFS if applied						
Details of area immersed in water with no AFS:						

Previous reports on the performance of the ship's AFS should be included, if applicable, and the AFS certificate or statement of compliance or other documentation should also be referenced, as appropriate.

The operation and maintenance of the antifouling system(s) used, including schedule(s) of activities and step-by-step operational procedures should be described. Reference can be made to Table 1 for expected life span and time between scheduled maintenance.

When maintenance or repair is performed to the AFS on an area of the ship, a report should be added to the BFRB providing documental evidence of the renewed AFS state. Reference can be made to Table B of Appendix 3 regarding best practices for reporting.

During dry-docking an evaluation of qualitative observations regarding the biofouling should take place to potentially align the evaluation of best practices between AFS manufacturers, cleaning organisations and shipyards.

ASSESSMENT of RISK PROFILES FOR HULL AND NICHE AREAS ON THE SHIP

The Plan should identify the hull areas and niche areas on the ship that are particularly susceptible to biofouling.

A diagram of the ship should be included in the Plan to identify the location of those areas (including access points in the internal seawater cooling systems). If necessary, the diagram should show both side and bottom views of the ship as in Figure 1 below. The hull may also be divided in different sections to indicate such areas.

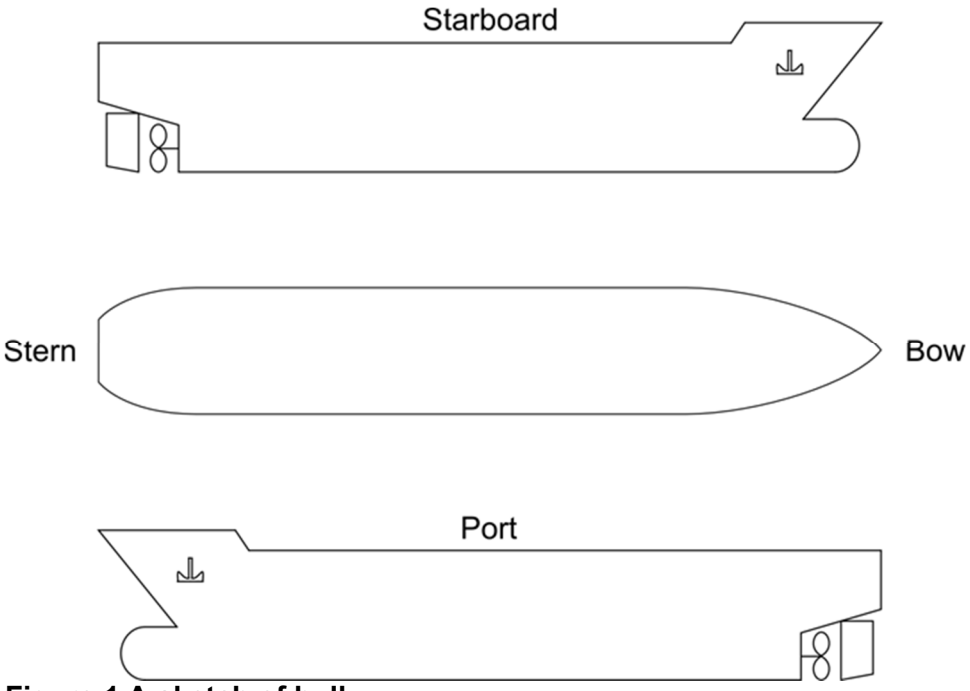

Figure 1 A sketch of hull

An assessment of the ship-specific risk of biofouling accumulation in niche and hull areas should be given as identified in Table 2 above. Based on a ship-specific risk profile per area, an inspection regime should be determined and included in the same table.

If the ship is changing its operating profile, it may be necessary to update the risk profile with relevant real-time parameters. How to update the risk profile, and how it impacts the inspection regime should be described in the Plan. For target areas with low risk for biofouling accumulation, the first inspection date should be within 12 months after drydock to confirm AFS systems are operating effectively. The inspection frequency for subsequent inspections may need to increase to confirm the continued effectiveness of an aging AFS.
A planned inspection should be conducted by an independent inspection organization. The outcome should define fouling ratings as described in chapter 8 of the Guidelines.
Details on the inspection conducted should be provided in a report in accordance with specifications in Appendix 2. Digital tools may be applied for the reporting. The activity should also be listed in the BFRB.

Table 2 Hull and niche areas and corresponding risk profiles and inspection details

Example of areas particularly susceptible to biofouling	Installation of MGPS, coating or use of other maintenance of the efficiency of the AFS such as clean hull measures (if any)	Risk for biofouling accumulation when operating under normal ship operating profile in accordance with the AFS (low, high)	Schedule of planned inspections of biofouling to be completed per area	Examples of methods to apply when inspecting each area
External surfaces, ref Figures 1 and 2:				
Bow				This area may be inspected by ROV
Bow thruster				
Hull below the waterline:				
Location X	AFS, type X	low	Every 12 months first 3 years after drydock, then every 6 months until next dry-dock	This area may be inspected by ROV
Location X				
Location X				
Location X				
Waterline:				
Location X				
Location X				
Location X				
Location X				
Flat bottom keel				This area may be inspected by ROV
Dry-docking support strips				
Bilge keels				
Sea chest gratings				
Location X				
Location X				
Stern				
Propeller and its shaft				This area may be inspected by diver
Rudder and rudder shaft				
Discharge pipes				
Rope guards				

Sounders/instruments				
Sacrificial anodes				
Internal seawater systems				Open up to inspect growth
….				
….				

MONITORING OF BIOFOULIGN RISK PARAMETERS AND RECOMMENDED ACTION

The ship specific biofouling risk parameters to be monitored should be determined and included in Table 4 below. The examples of biofouling risk parameters to be monitored when operating the ship are given in Figure 2 of chapter 7 and Table A of Appendix 1 in the Guidelines. When one of the parameters triggers an increased biofouling risk, it should lead to recommended actions, i.e. inspection and cleaning of the specific target area. It is recommended that the ship do its best to conduct reactive cleaning when necessary and correct any malfunction of coating or MGPS as soon as possible and keep a repair plan available to the relevant port State control authorities and the flag State.

If digital tools are applied for monitoring of biofouling risk parameters and/or digitalized real-data input are used for risk monitoring, these should be described. Monitoring parameters as identified in Table 4 should be as thorough as practicable but should focus on when actions are necessary.
A hull performance monitoring system can also be used as supplement to assess the changes in the propulsion power and fuel consumption of the ship, and the changes may indicate a degradation of hull or propeller condition.

Table 3 Monitored biofouling risk parameters per target area risk profile

	Examples of ship-specific biofouling risk parameters to monitor during operation	**Description of recommended actions given per low risk and high risk target areas**	
		low risk target areas	**High risk target areas**
1	Deviation from AFS specifications (e.g define acceptable speed, salinity temperature ranges)		
2	Deviation from AFS maintenance/service regime (e.g define non-acceptable deviations which may lead to higher risk)		
3	Deviation from regular clean hull measuresor necessary re-active cleaning (e.g define non-acceptable deviations which may lead to higher risk)		
4	Extended ship idle time (e.g define acceptable and non-acceptable idle time related to location/environmental conditions which may lead to higher risk)		
5	Performance loss as per PMS (e.g define non-acceptable deviations which may lead to higher risk)		
6	AFS damage (e.g define non-acceptable damage which may lead to higher risk)		
7	Downtime/malfunction of MGPS, clean hull measures or other AFS (e.g define non-acceptable damage or downtime which may lead to higher risk)		

8	Exceeding expected lifetime of AFS (e.g define at which lifestage of AFS may lead to higher risk and when exceeding will lead to very high risk)		

BIOFOULING CLEANING

This section should set out cleaning procedures that need to be applied to hull and niche areas when an inspection result recommends action as specified in paragraph 8.6 of the Guidelines.

Areas subject to clean hull measures should be specified in the Plan (reference can be made to Table 2).

Details on the reactive cleaning conducted should be provided in a report in accordance with specifications in Appendix 2. Digital tools may be applied for the reporting. The activity should also be listed in the BFRB.

CAPTURE AND DISPOSAL OF WASTE

In-water reactive cleaning should arrange for capture in accordance with paragraph 9.11 of the Guidelines. This section should describe disposal of biological waste generated from a cleaning process conducted by, or under the direct supervision of, the shipowner, master or crew.

When reactive cleaning is performed by a cleaning operator, documenting evidence of collection/delivery of the wastes (a receipt) should be appended to the BFRB.

The biofouling waste should be disposed of and/or treated in a safe and environmentally sound manner, in accordance with local regulations, and ensure that the main objective of the Guidelines, to minimize the transfer of invasive aquatic species, is safeguarded.

CONTINGENCY MEASURES

Even though procedures are followed in accordance with this Plan, a ship may detect an unforeseen biofouling accumulation. Contingency measure means a process undertaken on a case-by-case basis after a determination of an unforeseen biofouling accumulation despite best effort to monitor the biofouling risk parameters identified in this Plan. The aim of biofouling contingency measures are to manage the biofouling such that it does not pose any unacceptable risks to the environment, human health, property and resources.

The ship may not be allowed to enter a new harbour without taking a reactive response. If In general, the port/coastal State, the flag State and the ship should work together to agree on the most appropriate solution to allow for the ship to enter the waters under the relevant local authority.

Any contingency actions should be recorded in the BFRB.

SAFETY PROCEDURES FOR THE SHIP AND THE CREW

Details of specific operational or safety restrictions, including those associated with the AFS or MGPS systems that affects the ship and/or the crew.

Details of specific safety procedures to be followed during ship inspections and cleaning operations.

CREW TRAINING AND FAMILIARIZATION

This section should contain information on the provision of crew training and familiarization with the ship-specific biofouling management plan, based on chapter 13 in the Guidelines. The aim is to ensure broad knowledge of the Plan and actions for the ship.

APPENDIX 4 BIOFOULING RECORD BOOK (BFRB)

1 Introduction

The Guidelines recommend that a biofouling record book (BFRB) be maintained for each ship, in which should be recorded the details of all inspections and biofouling management measures undertaken on the ship.

2 Entries in the biofouling record book

An electronic BFRB may be applied (e.g. as integrated part of the ships Planned Maintenance System). The following information should be recorded in the BFRB:

2.1 When the hull and niche areas below the waterline have been subject to maintenance and clean hull measures:

a. Date and location of ship when clean hull measures occurred.

b. Hull and niche areas cleaned.

c. Methods of clean hull measures used.

d. General observations with regard to biofouling (i.e. extent of microfouling and macrofouling in accordance with the defined ratings) if any.

e. Reference to any supporting evidence/reports of the cleaning (e.g. report from supplier, photographs/videos and/or receipts) if any.

f. Name, position and signature of the person in charge of the activity.

2.2 When the hull and niche areas below the waterline have been inspected:

a. Date and location of inspection.

b. Areas inspected of the ship.

c. Observations with regard to biofouling (extent of microfouling and macrofouling in accordance with the defined overall fouling rates)

e. Reference to any supporting evidence/reports of the inspection (for guidance on reporting, see Appendix 2).

f. Name, position and signature of the person in charge of the activity.

2.3 When the hull and niche areas below the waterline have been subject to reactive cleaning:

a. Date and location of ship when cleaning occurred.

b. Hull and niche areas cleaned.

c. Methods of reactive cleaning used.

d. Estimation of overall biofouling after cleaning in accordance with the defined overall fouling rates.

e. Reference to any supporting evidence/reports of the activity (for guidance on reporting, see Appendix 2).

f. Records of permits required to undertake in-water cleaning if applicable.

g. Receipt or other documenting evidence of collection/delivery of the wastes.

h. Name, position and signature of the person in charge of the activity.

2.5 For ships with a MGPS fitted:

a. Records of maintenance (including regularly monitoring the electrical and mechanical functions of the systems).

b. Date and location of any instances when the system was not operating in accordance with the biofouling management plan.

2.6 Maintenance of AFS:

a. Date/period and location where the AFS maintenance was performed (e.g. dry-docked).

d. Any AFS, including patch repairs, that was applied during maintenance. Detail the type of AFC, the area and locations it was applied to (including the location of dry-dock support blocks if relevant), an estimated percentage cover of re-application of the AFC, the coating thickness achieved and any surface preparation work undertaken (e.g. complete removal of underlying AFC or application of new AFC over the top of existing AFC).

e. Reference to any supporting data for AFS maintenance (e.g. AFC technical file).

f. Name, position and signature of the person in charge of the activity.

2.7 Periods of time when the ship was laid up/inactive for a period beyond the expected period as specified in the BFMP:

a. Date and location where ship was laid up.

b. Date when ship returned to normal operations.

c. Inspections or biofouling management actions taken prior to and following the period laid up.

d. Precautions taken to minimize biofouling accumulation (e.g. sea chests blanked off).

2.8 Periods of time when the ship operated outside the expected operating profile as specified in the BFMP:

a. Duration and dates when ship is not operating in accordance with its normal operating profile.

b. Reason for departure from normal operating profile (e.g. unexpected maintenance required).

c. Inspections or biofouling management actions taken prior to and following the period when the ship is operating outside the expected operating profile.

2.9 Details of official inspection or review of ship biofouling risk (for ships arriving internationally, if applicable):

a. Date and location of ship when inspection or review occurred.

b. Port State authority conducting the inspection/review and details of procedures followed or protocol adhered to and inspector/s involved.

c. Result of inspection/review.

d. Name, position and signature of the person in charge of the activity.

SAMPLE BIOFOULING RECORD BOOK PAGE

Period from: …… To: .....

Name of ship .....

Registration number* .....

Gross tonnage .....

Flag .....

* Registration number = IMO number and/or other registration numbers.

The ship is provided with a biofouling management plan ☐

Date	Item (number)	Record of management actions	Report reference	Signature of officer in charge

Signature of master ……..……

***

APPENDIX 5 BEST PRACTICES FOR BIOFOULING INSPECTION

1 Introduction

The Guidelines recommend taking a proactive approach to biofouling including the development of procedures to carry out biofouling inspections and assessment of AFS condition.

Prior to performing an inspection (as applicable) It would be useful to first develop an inspection plan based on the BFMP and with focus on how to inspect low risk and high risk areas as identified in the BFMP. The ship's operational profile and previous biofouling records since the last inspection should also be taken into account to target potential susceptible areas during the inspection. The inspection plan would ideally be developed by the independent inspection organization in consultation with the ship's operator and crew. Potential difficulties in performing the inspection considering ambient conditions, time at berth (if being performed at berth), shipping traffic (if it is located close to a traffic lane) should also be considered.

Finally, the target areas and the scope of the inspection should be clearly identified.

The inspection should be performed in accordance with the inspection plan.

2 Recommended procedure defining target area for the inspection

An optimized inspection should be as thorough as practicable

The main principle is to assign a fouling rating for a section based on the worst fouling identified when inspecting the specific section. Sub-sectioning and additional inspection in the new sub-sections can be performed to get an extended inspection result.

- A recommended procedure for hull area:
    - For hull area (excluding niche areas); divide into 9 equally sized hull sections (port vertical side, starboard vertical side and flat bottom, each divided into front, mid & aft). For each hull section, inspect n x 1 m wide belt from waterline to bilge keel (on verticals) or from bilge keel to bilge keel (on flats), and assign a fouling rating (based on Table1 in the Guidelines) equal to the highest rated 1 m^2 identified along the belts. The length of the inspection belt (n) depends on the size of the section (e.g. 1 per 1 000 m^2, but no less than 1). Location of belt should be determined as a part of preparing the BFMP and should ideally include identifiable hull feature (e.g. draft marks)
- A recommended procedure for niche areas:
    - For each niche area, inspect full area and assign a fouling rating (based on Table1 in the Guidelines) equal to the highest rated 1 m^2 identified.

When an inspection result does not trigger a cleaning due to low fouling rating, the next scheduled inspection should ensure that the target inspection areas are extended, meaning more areas should be subject to inspection.

- A recommended procedure for extended inspection of hull areas:
    - For a more expended inspection, hull sections can be further divided into 2, 4, 8 or 16 equally sized sub-sections as needed. For each sub-section, inspect a

1m wide belt across the sub-section and assign a fouling rating based on the highest rated 1 m^2 along that belt.

3 Recommended procedure for biofouling inspection

Proposed inspection and cleaning equipment and technique:

- Cameras used for video and photographs should be able to obtain high definition color digital images while underwater
- Cameras should be capable of time and date stamping photographs, or capture this information in the digital file
- Individual images should be labelled to indicate the ship name, date, and area of the ship shown in the image
- Video should be taken at a slow enough pace to ensure blurring does not occur.
- Incorporate health & safety steps and actions to be taken by both the dive supervisor, host port, and ship operator

Proposed inspection and cleaning reporting

- It is recommended that all niche areas be shown in the report to allow for assessment by regulating bodies and ship operators.
- Reports may include additional information like written, numerical, or graphic summaries of the biofouling across the hull, however it is highly recommended that those be accompanied by images or video.
- It is recommended to provide both pre- and post-cleaning images

Dive and remotely operated vehicle (ROV) inspections can be practical options for in-water inspections although they do have limitations regarding visibility and available dive time compared with the area to be inspected, and difficulties with effectively accessing many biofouling prone niche areas.

Such inspections should be undertaken by persons who are suitably qualified and experienced and familiar with biofouling and associated invasive aquatic species risks and the safety risks relating to in-water inspections. Regulatory authorities may have recommended or accredited biofouling inspection divers.

Using digital tools to process photos and videos may be effective in terms of accurately processing fouling rating related to time and location.

[Recommended procedures to be further developed.]

4 Recommended procedure for biofouling inspection of niche areas

[Recommended procedures including photos and assessment of photos to be developed.]

5 Recommended procedure for assessment of AFS condition

Performance monitoring of AFS should include areas that may be more prone to coating damage such as tug-points, fender points, anchor chain abrasion and areas that are left dry during voyages with less cargo.

Possible damage to the AFS should be monitored when in ports or anchorages where high tidal variations result in the ship standing on the seabed during low tides.

[Further recommended procedures including photos to be developed].

APPENDIX 6 BEST PRACTICES FOR BIOFOULING CLEANING ACTIONS

1 Introduction

The Guidelines recommend biofouling management actions including the development of procedures to carry out biofouling cleaning and AFS maintenance.
[

2 Recommended clean hull measures

Clean hull measures include hull grooming and may be used in order to prevent or minimize the attachment and growth of microfouling. For the cleaning to be proactive, any biofouling must be removed before it reaches the macrofouling stage, and before removing attachment of biofouling may result in damage to or erosion of the paint or coating on the hull.

Clean hull measures comprise frequent and gentle wiping of the hull or using other hydrodynamic forces, using divers or remotely operated vehicles (ROVs). Methods includes using soft brushes, water jets, or contactless systems.

The following items should be fulfilled in order to comply with the practice of clean hull measures.

2.1 Basic documentation

Any procedure for clean hull measures should be documented by the cleaning system manufacturer and operator with an account of its working principle and operational requirements, including:

- Equipment to be used, with specific manufacturers/models.
- Relevant submerged area where the equipment can be used and what areas are excluded (e.g. specific hull features, extreme curvature, etc.)
- Other operational requirements or limitations (e.g. wind, waves, temperature, daylight, etc.)

2.2 Avoid hull performance reduction

Clean hull measures should remove biofouling before it causes a significant reduction in hull performance. A commonly used industry benchmark of “significant reduction” is 1.5 % reduction in over average hull performance according to ISO 19030-2.

2.3 Fouling rating identification and documentation

Clean hull measure operations are restricted to areas with biofouling rating ≤ 1 in accordance with Table 1 in chapter 8. The cleaning system manufacturer and operator should document that procedures are in place to:

- identify areas with biofouling at stage ≥ 2 as per Table 1 in chapter 8;
- avoid these areas during the clean hull measure.

In order for a port or other relevant jurisdiction to be able to verify that Clean hull measures has only done on areas with fouling rating ≤ 1 in accordance with Table 1 in chapter 8, the cleaning system manufacturer and operator should agree to capture, store and make available to the relevant jurisdiction video of the full Clean hull measures operation, where video should be of sufficient quality to allow determining the fouling rating of relevant areas.

Areas identified with fouling rating ≥ 2 in accordance with Table 1 in chapter 8 should be recorded. Such areas may undergo in-water cleaning in accordance with paragraph 9.13.

2.4 Avoid damage to or erosion of ship's AFC

The cleaning system manufacturer and operator should document that the equipment and method is in accordance with recommendations from the ships's AFC manufacturer in order to avoid damage to or erosion of AFC. In case of biocide-containing AFS, there should be no visible sign of the cleaning resulting in erosion to the intact AFS beneath the leached layer.

2.5 Other concerns

In addition to the aforementioned recommendations, the following should be documented:
- Clean hull measures operations should not interfere with normal port operations.
- Health and safety aspects: The procedure should not pose any unusual risks for human health or the environment during the complete phase of operation including launching, operation, retrieval and stowage of equipment.]

3 Recommended practice proactive action

Hull wrapping may be applied when the ship is at anchoring or berthing. The submerged area is covered with a synthetic resin sheet to prevent fouling on the hull surface. It is expected to reduce the adhesion of organisms to the hull surface, reduce the maintenance load, and protect the surface of the AFC.

[To be further developed.]

4 Recommended practice for MGPS

An MGPS may include one or some combination of the following technologies:

- Chemical injection
- Electrolysis
- Ultrasound
- Ultraviolet radiation
- Electrochlorination
- AFC
- Cupro-nickel piping

[To be further developed.]

5 Recommended procedure for reactive cleaning of hull and niche areas

The methods listed below are for guidance only and are not exhaustive:

1. Cleaning systems may be mechanical:
    a. brush based. Brush systems are a widely used method for in-water hull cleaning due to their ability to remove surface deposits and low levels of biofouling from biocidal coatings.
    b. cutting head
    c. water jet-based systems
    d. diver operated carts
    e. remotely operated vehicles
2. Cleaning systems may be manual:
    a. powered handheld tools
    b. non-powered handheld tools

[Recommended procedures including photos to be further developed].

5 Recommended procedure for capture, containment and treatment of waste

[Recommended procedures to be developed].

6 Recommended procedure for handling, harmful waste substance

[Recommended procedures to be developed].

7 Assessment of environmental risks related to in-water cleaning, including risk of releasing harmful waste substances from AFS

[Recommended procedures to be developed].

9 Assessment of environmental risks for the dry-dock cleaning facilities

[Recommended procedures to be further developed.]