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GLOBAL TESTNET GUIDELINES FOR THE EVALUATION OF EFFICACY OF MARINE GROWTH PREVENTION SYSTEMS (MGPS)

Contents

DEFINITIONS:

Antifouling system: "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, as defined by the IMO's International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS Convention), adopted on 5 October 2001.

CAPEX: Capital expenditure

MGPS: Marine growth prevention systems - MEPC.378(80) (The 2023 IMO Biofouling Guidelines) defines these as "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."

Test Rig: a complete experimental setup used to evaluate the **MGPS** efficacy. It includes water handling system (e.g., pump), piping, and **representative structures** (e.g. simulated sea chest, piping, and sea valve), The test rig must enable simultaneous testing of treated and control lines under static and dynamic conditions.

Representative structures: Physical components within the **test rig** simulating niche areas such as sea chests, grates, internal piping and sea valves. These structures serve as the substrate for biofouling evaluation and typically include:

- Simulated sea chest (≥1 m^2 internal wall area) with grates
- 2 m pipe length
- Transparent pipe section for visual inspection
- Simulated sea valve.

Defined Location: A pre-marked and standardised surface area on the **representative structure** where fouling is assessed. This includes:

- The grate (bars or grills) simulating the sea chest opening
- Marked areas of 15 cm^2 on the internal wall surfaces of the representative structure (e.g., side, bottom, and top panels)

Defined locations shall be used consistently across control and test lines to allow reliable comparison of fouling ratings.

OPEX: operational expenditure

SDL: System Design Limitation

INTRODUCTION AND BACKGROUND

Background

The 2023 Guidelines for the Control and Management of Ships' Biofouling to Minimise the Transfer of Invasive Aquatic Species (hereafter referred to as the "IMO Biofouling Guidelines") (MEPC.378(80)) introduce a set of voluntary measures to assist vessel operators to manage biofouling.

Biofouling of the internal water systems in a vessel has implications for their performance. Raw water intakes (sea chests) and the associated water systems of a vessel are subject to considerable fouling pressure and are often complex and inaccessible to maintenance operators.

Biofouling is generally managed using antifouling coating systems (IMO AFS Convention, 2001) However, surface preparation and application of antifouling coatings to a high standard in sea chests and internal piping is challenging. Also, most antifouling coatings are designed for use on exterior hull plate and may not perform optimally in the more complex architecture of a sea water cooling system. Consequently, there is often a need for an MGPS to provide additional antifouling protection in these water systems.

Article 6.1 of the IMO Biofouling Guidelines describes MGPS as one of the key antifouling systems used to prevent or reduce biofouling on ships. Modes of action include but are not limited to: copper ion dosing, sodium hypochlorite dosing, freshwater flushing, ultraviolet light treatments, acoustic treatments, cathodic and electro-chlorination systems and Cu/Ni piping (which has antifouling properties).

The relative performance of MGPS, in terms of both their antifouling performance and their impacts on other systems (e.g. coating systems) is largely driven by on-board experience rather than consistent assessment or evaluation. Importantly, there is a lack of standardised test methods to compare the efficacy of different MGPS based on different modes of action, or the efficacy of one mode of action configured in different ways. This makes it challenging for the ship operator to:

- Compare the efficacy of different MGPS to select the optimum system for their operational profile of the vessel;
- Make comparisons between the CAPEX and OPEX of different MGPS;
- Ensure that the MGPS approach selected is compatible with other antifouling and corrosion protection systems on the ship; and
- Ensure the MGPS is compliant with local, regional or global environmental standards.

Scope covered by these guidelines

MGPS are used in a range of different applications on vessels, including very different flow rates, dilution levels and differences between the architecture of the structures involved. Therefore, one single test method is unlikely to cover all of these scenarios adequately.

The scope of this document is limited to MGPS systems that are designed to be used within a sea chest to provide antifouling protection to the interior of the sea chest, the outer grating, and the first 1-2 m of piping and the main sea valve immediately downstream of the sea chest. It aims to provide guidance to end users to select the optimum MGPS for a given scenario.

The test plan should include, if identified, the compatibility of the MGPS with other ship technologies including antifouling control technologies, such as other MGPS or antifouling coatings.

GENERAL PRINCIPLES

General principle for the evaluation of MGPS technologies

MGPS should be safe for the ship, the crew and the environment where it is used. A report documenting the testing should be produced and retained on-board as part of the Biofouling Management Plan for the vessel.

The MGPS should be tested in a range of salinities and temperatures in which the MGPS is intended to work.

The testing and verification should account for how factors such as water quality and fouling pressure can influence MGPS performance. This enables repeatable and consistent testing of MGPS, as well as comparison between tests, to enable ship operators to select technology based on performance data to achieve the highest level of biofouling prevention possible in the sea chest and adjacent piping.

Comparative MGPS efficacy tests should be performed using field test rigs that are designed to simulate conditions encountered in ships sea chests and piping systems. This is to provide realistic data regarding potential performance. In addition, monitoring and controlling as many variables with the potential to affect antifouling performance should be conducted as far as is practically possible, to help separate the performance of the MGPS from other variables that affect biofouling accumulation.

The MGPS technology should be tested under a range of relevant environmental conditions and simultaneously compared to “control” biofouling conditions, where no active biofouling prevention is undertaken. This should provide a repeatable and comparable assessment of antifouling performance that can be extrapolated to a range of geographic scenarios. Where possible, such testing should occur in different geographical zones (e.g. temperate, tropical) to provide an informed view of MGPS performance in different environments, see section 8.

Test organisations applying this method should, according to their Quality Management Plan, have sought and achieved any relevant local, regional or national environmental permits required to undertake such testing, which by its nature requires the uptake and discharge of raw water to a marine environment, and in many cases, involves dosing the water with active substances.

Monitoring of active substances in the discharge water stream and neutralisation of active substances prior to discharge are likely to be required.

In cases where the active substance dose is demonstrably below relevant regulatory thresholds (e.g., copper ion concentration), the discharge may be considered negligible and not subject to permit requirements. In such instances, the testing organisation should provide a justification of exemption based on national guidance or risk screening, and this should be documented in the test plan and final report.

MGPS technology is developing rapidly, and different versions and models of similar technology using fundamentally analogous modes of action are appearing on the market frequently. No upgrades or redesigns should be allowed during formal testing, and if modifications are required, complete retesting of the MGPS should be conducted. In particular, major components that affect the mode of action of the systems should not be changed during testing.

Health and safety considerations

Health and safety consideration should be taken into account at the time of the MGPS development as well as when testing is carried out:

- MGPS used onboard ships should be safe for the crew, the ship and the environment.
- The testing of MGPS has the potential to involve a range of health and safety risks to personnel, many of which are specific to the arrangement of the test rigs and the systems being tested, but they also include aspects such as electrical, mechanical, chemical, acoustic risks, and the risk of DNA damage, as well as many others. All matters concerning health and safety are beyond the scope of this document and will be the responsibility of the testing organisation and will be addressed full in the Quality Management Plan.

Continuous improvement

The testing and standardisation of MGPS is an emerging field. While much can be learned from the testing and approval process of comparable marine technologies such as ballast water treatment systems, there are many unique aspects of MGPS which provides specific challenges when developing a uniform testing approach. As such, this document provides a starting point for standardisation of test methods, but information and constructive feedback from competent testing organisations should be used to revise and improve these guidelines.

QUALITY ASSURANCE OF TESTING ORGANISATIONS

To achieve consistency, confidence, and transparency of the test results, the MGPS test procedure should be conducted, at a minimum, to the standards described in this document, by an organisation with suitable experience and competency.

The testing organisation should be independent from the manufacturer of the technology to ensure impartiality in the evaluation.

The testing organisation should have documentation in place to ensure quality. Documentation should include but is not limited to:

- A Test Quality Management Plan
- A Quality Assurance Project Plan
- A Conflict-of-Interest Policy
- Standard Operating Procedures
- Curriculum Vitae of experts
- If available, proof of quality management systems such as that described in ISO 17025 or equivalent.

GENERAL APPROACH

Experimental approach

The general approach used in this method is to conduct field tests. Test will be completed by installing the MGPS in a waterside test rig and raw or untreated water will be pumped through the rig and into representative geometries which are being protected by the MGPS on test. Each test line incorporates a complete set of representative structures (see Definitions), designed to simulate a ship's sea chest and adjacent piping components. These structures serve as the substrate for biofouling assessment and ensure comparability between treated and control conditions (Figure 1).

To account for the impact of flow rate on representative geometries of the MGPS performance;

- the dynamic test lines with the flow velocity in the pipes through the system set to a flow representing the MGPS system design limitation
- the static test lines have an extremely low flow through rate through the system (e.g., 0.1m/s) and stimulates the worst-case fouling conditions when the vessel is idle.

The ability of the MGPS to prevent biofouling from developing on the representative geometries is measured and compared to a separate control line in the test rig which consists of a replicate set of representative geometries, but with no MGPS or other antifouling system present.

While MGPS tests are typically scheduled for a nominal period (e.g., 3 months), actual test duration may vary depending on the biofouling pressure observed. The testing organisation shall plan for seasonal variability and reserve the ability to extend or repeat the test if fouling is insufficient for evaluation.

Evaluation of the MGPS efficacy

The following endpoints shall be used to evaluate MGPS efficacy, based on the fouling rating scale (0 to 4) defined in the 2023 IMO Biofouling Guidelines. Fouling is visually assessed and assigned a rating at defined locations (see Definitions) on the representative structures within the test and control lines. Comparisons shall be made between matching locations in treated and untreated lines (e.g., grate vs. grate, wall vs. wall). All endpoint assessments shall be supported by photographic documentation and/or visual observation logs. Care should be taken during the quantification procedure not to disturb the biofouling.

Primary endpoints:

- Fouling rating on the grate simulating the opening of the representative structure.
- Fouling rating on 15 cm² marked areas on the internal panels of the representative structure (e.g., side, bottom, and top surfaces). Marked area should be away from the edges.
- Visibility through a 30 cm long optically clear (transparent) section of pipe downstream of the sea chest (i.e. clear, partially obscured, fully obscured by biofouling).
    - Clear: Minimal fouling: More than 90% of the inner pipe surface is visible (fouling covers <10% of the surface)
    - Partially obscured by biofouling: Between 90% and 10% of the inner pipe surface is visible (fouling covers between 10% and 90% of the surface)
    - Fully obscured by biofouling: Less than 10% of the inner pipe surface is visible (fouling covers >90% of the surface)
- The effect of biofouling of the sea valve will be measured by attempting to close the value at the end of the test and measuring flow rate down stream of the valve. If the valve does not close fully, or allow measurable residual flow, the test is failed.

General performance criteria

Test scheduling should aim to span peak local fouling periods to maximize the chance of achieving a sufficient biological endpoint.

- The test duration shall be sufficient to allow the static control line to reach fouling rating ≥3. This condition defines test validity (see Evaluation Criteria). The actual duration may vary depending on local fouling pressure. (Table 1 of the IMO Biofouling Guidelines). When testing is carried out at sites with known seasonal variation in biofouling pressure, the test should be conducted over the peak of the larval supply season (i.e., in the U.K., between March and September).
- In the event that the fouling in the static control does not reach level 3 within the scheduled test period, the test duration should be extended. If fouling rating 3 is still not reached, the test may be deemed inconclusive or repeated during a later fouling window, as agreed with the test organisation.
- The biofouling challenge or larval supply in the raw test water will vary temporally throughout the year at one site, and at the same site from year to year. The biofouling challenge will also vary spatially between sites and locations. As far as possible, testing should be repeated in distinct bioregions which typically experience different levels of fouling pressure and different species composition within the fouling assemblages to reduce uncertainty around MGPS performance. When testing is not repeated in different bioregions the impact of temperature should be evaluated.
- The water used should be natural and not recycled.
- The report should include a characterisation of the organism types found in the test water at regular intervals across the duration of the testing. For example, if testing occurs during a period without bivalve larvae present, the outcome may not predict real-world performance.

MGPS System Design Limitations (SDL)

The water quality parameters used for the testing should represent the conditions under which the MGPS is intended to work. System design limitations, as far as possible, should be identified prior to testing, and the testing regime should be designed to verify the efficacy of the system as much as possible.

The objective of defining the System Design Limitations is two-fold. Firstly, it ensures that the performance of the MGPS has been transparently assessed with respect to the known water quality and operational parameters that are important to its operation, including those that may not be specifically provided for in these Guidelines. Secondly, it provides transparent oversight of manufacturer MGPS performance claims that may go beyond specific criteria in these Guidelines.

Evaluation criteria

The biofouling levels measured in the dynamic and static test lines (with MGPS) and control lines (no MGPS) shall be classified according to the IMO Biofouling Guidelines.

A test is considered valid only when the static control line reaches a fouling rating of ≥3 (based on the IMO biofouling scale). This requirement ensures sufficient fouling pressure to evaluate MGPS efficacy.

Test duration shall be extended if necessary to meet the fouling threshold. If rating 3 is not reached in the static control within the expected test window, the test may be extended, repeated, or deemed inconclusive, as pre-defined in the test plan.

A successful result is defined as the biofouling rating in the test line (with MGPS) being at least two levels below the rating in the corresponding control (static or dynamic). The fouling shall be measured at defined location on the representative structure (see Definitions), specifically at both the grate and a marked area on the side wall. Rating comparisons shall be made between the same type of location in test and control lines (e.g., bar vs. bar, side wall vs. side wall).

Special condition for dynamic test line: In case the dynamic control line does not reach fouling rating 3, the test line must not exceed fouling rating 2, and the biofouling rating in the dynamic test line must be strictly lower than that of the dynamic control line.

The MGPS performance is also evaluated on its operational robustness, and a record of operational down time and any system failures are used in the final evaluation.

Practical Guidance Summary

- Test validity is based on the static control line reaching fouling rating ≥3 (see Evaluation Criteria).
- For efficacy evaluation (Pass/Fail), the fouling rating in the corresponding control line (static or dynamic) is used.
- Special condition for dynamic tests: If the dynamic control line is rated <3, the test line must be rated ≤2 and strictly lower than the control.

Table 1 MGPS Efficacy Pass/Fail Matrix in the static test

Control Line Fouling	Test Line Fouling	Pass/Fail	Reason
Rating <3 (static)	–	⚠️ Invalid test	Static control < Rating 3, Invalid for both static & dynamic evaluations
Rating 3	Rating ≤1	✅ Pass	Δ ≥ 2 Ratings
Rating 3	Rating ≥2	❌ Fail	Δ < 2 Ratings
Rating 4	Rating ≤2	✅ Pass	Δ ≥ 2 Ratings
Rating 4	Rating ≥3	❌ Fail	Δ < 2 Ratings

Table 2 MGPS Efficacy Pass/Fail Matrix in the dynamic test

Control Line Fouling	Test Line Fouling	Pass/Fail	Reason
Rating <3 (static)	–	⚠️ Invalid test	Static control < Rating 3, Invalid for both static & dynamic evaluations
Rating <3	Test ≥ control	❌ Fail	Test not strictly lower than control
Rating <3	Test < control & Rating ≤2	✅ Pass	Special condition for low dynamic control
Rating 3	Rating ≤1	✅ Pass	Δ ≥ 2 Ratings
Rating 3	Rating ≥2	❌ Fail	Δ < 2 Ratings
Rating 4	Rating ≤2	✅ Pass	Δ ≥ 2 Ratings
Rating 4	Rating ≥3	❌ Fail	Δ < 2 Ratings

EXPERIMENTAL SETUP AND TEST RIG DESIGN REQUIREMENTS

Key Requirements of the rigs

Replicability and comparability between test and control lines must be ensured by consistent construction and operating conditions. Use of a single replicate per condition is permitted, as long as performance data are supported by robust QA procedures and control lines demonstrate sufficient fouling pressure. While some degree of variation between test approaches is expected, there are several key requirements that the test rig must meet in order to provide comparable and repeatable results. These requirements are detailed below:

- A complete test for evaluation of efficacy must include one static flow test and one dynamic flow test[1] using at least one test replicate and one control replicate per condition.
- The test rig, as defined in the Definitions section, includes both water handling systems and representative structures. It must be constructed of suitable non-toxic materials. Suitable components and compatible fixings should be used to enable the test rig to sustain long-term exposure to harsh marine environments including continuous exposure to fully saline water and active substances including but not limited to, copper ions, chlorine and ultraviolet light.
- The test rig must not incorporate the use of any other antifouling control technology (such as antifouling coatings, copper rich alloys etc) that could affect or influence the measurement of antifouling performance generated within the test line (with MGPS) and control line (no MGPS), unless the purpose is to evaluate the impact of the MGPS on such technology as described in the specific project plan.
- The test rig must be capable of maintaining the MGPS at the duty cycle recommended by the manufacturer for the duration of the test.
- The construction of the test rig shall be such that little or no light ingress occurs onto the representative geometries to ensure the biofouling assemblage can be dominated by invertebrates and not algae.

Representative Structures

As defined in the Definitions section, representative structures are shipboard analogues used to measure biofouling accumulation. Each set includes a simulated sea chest, pipe section, transparent pipe, and sea valve. These are fabricated from non-toxic materials and arranged consistently across all test lines. Each representative structure includes the following elements:

- Simulated sea chest (at least 1 m^2 internal walls only) and grating.
- Pipe leading from the outlet of the sea chest.
- Simulated sea valve in the pipe after the transparent section from the outlet of the sea chest.

[1] A minimum of one replicate per condition is required for a valid test result. Use of additional replicates (e.g., three per condition) is encouraged where resources allow, as this improves confidence in the consistency of the MGPS performance under varying conditions. However, no formal statistical confidence level is defined at this stage.

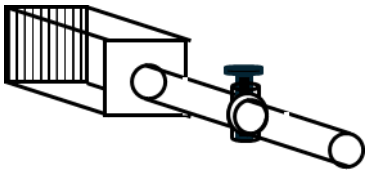

Figure 1: Representative structure used in each test line (see Definitions), including a simulated sea chest, 2 m of pipework, and a sea valve for biofouling evaluation. Please note the reduced scale to allow for experimental replication in the test.

- As a minimum, four identical sets of representative structures shall be integrated within the test rig, each with separate water supply controls, to support static and dynamic test lines (with and without MGPS):
    - Dynamic Control line (no MGPS treatment) x1
    - Static Control line (no MGPS treatment) x1
    - Dynamic Test line (with MGPS treatment) x1
    - Static Test line (with MGPS treatment) x1

A complete test shall include one static test line and one dynamic test line, each with a corresponding control line (i.e., four test lines in total). The setup described in Figure *2*, using one replicate per condition, is sufficient for valid efficacy evaluation, provided rig conditions remain consistent and properly documented. Use of additional replicates is optional and may be specified in the project plan if statistical comparison is required.

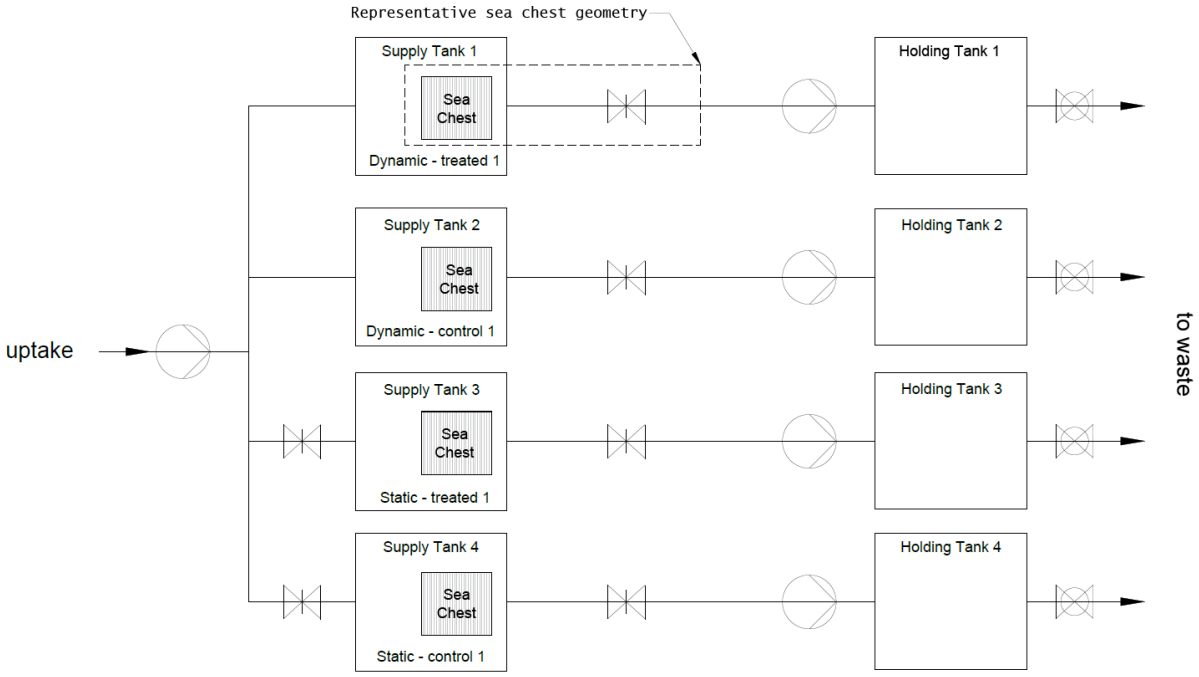

Figure 2: Plan view of a representative MGPS test rig with four test lines (static and dynamic; treated and untreated). This configuration uses one replicate per condition and complies with test rig requirements.

Control Line

The test rig must incorporate control lines to enable simultaneous uptake of raw test water through representative geometries without antifouling protection in place to serve as a control to compare the antifouling performance of the MGPS against. This is repeated for both static and dynamic conditions.

Sampling Access

The test rig shall provide the operator safe access to the representative structures (see Definitions) to enable regular sampling, inspection, and documentation throughout the test period.

It must support the following activities:

- Image and data capture of biofouling accumulation on key surfaces (gratings, wall, and pipes), performed at monthly or more frequent intervals by trained.
- Water quality monitoring with access points positioned to allow representative sampling before and after the MGPS (Table *3*).
- Environmental instrumentation, including space and connectivity for sensors (e.g., temperature, salinity, flow) capable of recording continuous time-series data, in accordance with Table *3*

Alternatively, if appropriate to the parameter being measured, the test rig must incorporate suitable sampling ports to enable the operator to withdraw representative water samples to measure parameters at the stated frequency. The precision, accuracy, and calibration schedule of instruments

required for environmental monitoring shall be the same as or equivalent to ISO17025 and manufacturers requirements.

Maintenance And Down Times

The test rig will require regular maintenance:

- The test rig should be fabricated to allow for regular and safe maintenance and inspection of internal sections to be conducted, and with spare critical parts in stock to allow rapid replacement to minimise downtime during the test should they become compromised or fail.
- Critical components such as uptake pumps should be cycled on a preventative maintenance schedule, e.g., one unit in operation, one unit being maintained and serviced, and one unit in store as a spare.
- All practical steps should be taken to reduce the maintenance and downtime during the test, with all down time and maintenance time being recorded and described in the test report. Down time must be less than 10% in total and less than three consecutive days over the entire test duration for a test to be considered valid.

The MGPS may require maintenance (e.g. change of chemicals or calibration). Scheduled and non-scheduled maintenance and down-time should be reported by the testing facility as to evaluate the "time between failures" of including both the MGPS and the supporting test rig infrastructure.

Water Supply

The test rig must be able to simultaneously test the performance of the MGPS under:

- Static conditions, representing worst-case fouling scenario with very low flow rates through the representative structures (Static Test Line), and
- Dynamic conditions, simulating typical operational flow rate of a typical sea chest (Dynamic Test Line).

The test rig must be situated in close proximity to an unrestricted volume of natural water to enable continuous uptake and delivery of natural water to the test rig, together with any short-term holding of discharge water, if required for neutralisation, before returning back to the environment.

The water uptake and discharge lines should be located in positions selected with consideration to local tidal and other hydrodynamic factors to minimise the chance of cross contamination and excessive sediment uptake occurring. Unless hydrodynamics factors ensure that the cross contamination is limited, then the distance between the inlet and discharge should be >10m

To ensure for better comparability of the testing conditions, the technology used by the testing facility to pump the water through the different lines should be evaluated and designed to:

- Maintain consistent and controlled flow rates,
- Minimize the impact of biofouling organisms,
- Allow independent flow control to each test line.

The following should be taken into account when evaluating the design of the pumping structure:

- Pumping rates and pressure stability
- Type of pumps (diaphragm, rotary, piston, centrifugal…) and valves,
- Avoidance of turbulence that could affect settlement or survival of organisms

All components in contact with water must be constructed of materials suitable for long-term marine exposure (if relevant) and compatible with the MGPS treatment method being tested (e.g., resistant to copper, chlorine, or UV).

Test Water Criteria
The MGPS must be tested under the conditions for which they are intended to be used.

The following variables will be monitored as described below. Please note that all discharge water will need to be checked for regional and national compliance by the test organisation.

Table 3 Sampling Requirements

Note: Temperature, salinity and turbidity shall be monitored after the MGPS (waste stream) depending on the mode of action. Temperature shall be monitor after the MGPS in the static test.

Parameter	**Sampling frequency**	**Location**	**Purpose**
Temperature*	Continuously	Before the MGPS	Characterization of test water
Salinity *	Continuously	Before the MGPS	Characterization of test water
Flow rate	Continuously	After the MGPS	Verification of operational conditions
Turbidity* (UV MGPS only)	Continuously	Before the MGPS	Characterization of test water (UV MGPS only)
Active substances if relevant (e.g., chloride, copper ions)	Monthly or more frequently if necessary	After the MGPS	Monitoring of treatment / processed water
Disinfection byproducts (if relevant)	Monthly or more frequently if necessary	After the MGPS	Evaluation of DBP formation in processed water
POC/DOC (these affect chlorine and UV efficacy)	Monthly or more frequently if necessary	Before the MGPS	Characterization of test water (affecting efficacy)
Zooplankton (optional)	Twice a month	Before the MGPS	Determine the presence of organisms capable of biofouling
Biofouling accumulation	Monthly or more frequently if necessary	At defined locations on the representative structures (i.e., grate and 15 cm^2 marked areas)	Biological effect – main efficacy indicator
Pipe visibility	End of test	Transparent pipe section	Secondary visual indicator

Parameter	Sampling frequency	Location	Purpose
Sea valve operability	End of test	Downstream valve	Mechanical obstruction assessment

Fouling Monitoring Requirements

Biofouling accumulation shall be assessed as described in Table *3*. Visual inspections and digital imaging shall follow standardised protocols to ensure reliable comparison. Staff performing assessments must be trained and competent.

Fouling shall be evaluated at defined locations on the representative structures (i.e., at the grate and at 15 cm^2 marked areas on internal panels, see Definitions), using the fouling rating scale (0 to 4) defined in Table 1 of the IMO Biofouling Guidelines. Assessments may be performed either in situ or through image documentation, but must always result in a consistent rating assignment.

Percentage cover may be used internally to guide rating assignment but shall not be reported as the formal outcome.

All fouling comparisons between test and control lines shall be performed at matching defined location. The comparison of biofouling ratings must be based on equivalent areas (e.g., grill to grill, side wall to side wall) to ensure reliable outcome assessment.

Operational Maintenance Recording

MGPS operation and maintenance requirements should be recorded and reported. This may include but is not limited to power consumption, time between failures, consumable and maintenance needs.

GUIDANCE FOR EVALUATION OF PERFORMANCE OF MGPS BASED ON UPSCALING AND DOWNSCALING MODELS

The test rig must be able to incorporate an MGPS system of sufficient scale to apply its particular mode of action at the representative, effective and operationally relevant level or dose, but in proportion to the scale of the representative geometries in the test rig.

It should be demonstrated by using mathematical modelling and/or calculations, that any up or down scaling of the MGPS will not affect the functioning and effectiveness on board a ship of the type and size for which the equipment will be certified. In doing so, the manufacturer of the equipment should take into account the relevant guidance developed by the test organization.

Scaling information should ensure that any scaled model is at least as robust as the tested model.

Successful completion of the scaling evaluation should be verified at full scale on a ship based test, however ship based testing is beyond the scope of this document.

REPORTING OF TEST RESULTS

The report should be produced by the test facility and include information necessary to ensure that the conclusion of the report is supported by robust testing data.

The report should include:

- the name and address of the laboratory performing or supervising the inspections, tests or evaluations, and its national accreditation or quality management certification, if appropriate;
- the name of the MGPS manufacturer;
- the trade name, product designation (such as model numbers), and a detailed description of the equipment or material inspected, tested or evaluated;
- an executive summary of the test, results and performance of the MGPS;
- the experimental design;
- methods and procedures including an estimation of the sources and levels of uncertainty from the testing organisation
- results and discussion, including the fouling levels in each tests and controls, the species assemblage composition, water qualities monitored during the tests, and any other associated measurements which may be deemed necessary
- MGPS and rig maintenance logs, time between failures and any observed effects of the MGPS on other systems of the ship (e.g. pumps, pipes, tanks, valves).
- a section describing how compatibility with other ship technologies has been assessed.
- the operational safety requirements of the MGPS and all safety-related findings that have been made during the inspections, tests or evaluations
- Any other supportive documentation as found appropriate by the testing organisation
- Details about which flows the MGPS were tested with average and standard deviation for the test period and for each line (control and test)