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ANY OTHER BUSINESS

Proposed guidelines for the evaluation of efficacy of Marine Growth Prevention Systems (MGPS)

Submitted by Global TestNet

SUMMARY

Executive summary:	This submission presents information on how to address the lack of standardized test methods to compare the efficacy of different Marine Growth Prevention Systems (MGPS) based on different modes of action, or indeed the efficacy of one mode of action configured in different ways. However, the relative performance of MGPS, in terms of both their anti-fouling performance and their impacts on other systems (e.g. coating, anti-corrosion…) is largely driven by empirical experience rather than consistent assessment/evaluation. This document describes principles and a test methodology that enable direct comparison of the efficacy of different MGPS under comparable conditions. This will allow end users to select the optimum MGPS for a given scenario.
Strategic direction, if applicable:	1
Output:	Not applicable
Action to be taken:	Paragraph 10
Related documents:	PPR 12/5/Rev.1and resolution MEPC.378(80)

Background

1 The Committee adopted the *2023 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species* (hereafter "the 2023 Biofouling Guidelines") by way of resolution MEPC.378(80).

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

3 Biofouling impacts are managed using anti-fouling systems (AFS Convention, 2001) and may include marine growth prevention systems (MGPS) often in conjunction with anti-fouling coatings (AFC). However, high-quality surface preparation and application of anti-fouling coatings in sea chest areas and internal piping is challenging. For that reason, the report from the Correspondence Group on Development of Guidance on Matters Relating to In-water Cleaning notes that all AFC may not perform the same depending on the operational profiles of ships but also the area where they are applied (e.g. gratings, rudders and sea chests) (PPR 12/5/Rev.1).

4 The 2023 Biofouling Guidelines recommends choosing a combination of AFC and MGPS, suitable for different submerged areas in order to minimize biofouling in such hardly accessible areas of the hull. Modes of action of MGPS include but may not be limited to: copper ion dosing, sodium hypochlorite dosing, fresh water flushing, ultraviolet light, acoustic, cathodic and electro-chlorination systems and Cu/Ni piping (which has biofouling protection properties).

5 However, the relative performance of MGPS, in terms of both their anti-fouling performance and their impacts on other systems (e.g. coating, anti-corrosion), is largely driven by empirical experience rather than consistent assessment/evaluation. There is a lack of standardized test methods to compare the efficacy of different MGPS based on different modes of action, or indeed the efficacy of one mode of action configured in different ways. This makes it challenging for the ship operator to: 1) compare the efficacy of different MGPS to select the optimum system for their operation; 2) make comparisons between the CAPEX and OPEX of different MGPS; 3) ensure that the MGPS approach selected is compatible with other anti-fouling and corrosion protection systems on the ship; and 4) ensure the MGPS is compliant with local, regional or global environmental standards.

Proposals

6 Global TestNet members have prepared a globally applicable guidance document which describes principles and a test methodology that enable direct comparison of the efficacy of different MGPS under comparable conditions. The guidance is intended to allow end users to select the optimum MGPS for a given scenario.

7 In its current version, this guidance is limited to MGPS that are designed to be used within a sea chest to provide anti-fouling protection to the interior of the sea chest, the outer grating, and the first metre of piping after the sea chest.

8 Members of the Global TestNet have agreed to endeavour in implementing these guidelines as far as commercial agreements with MGPS providers allow. In an effort to encourage other testing organizations to align with similar principles and support a uniform evaluation of MGPS globally, the Global TestNet members have decided to render this document public and hope that delegations will support the sharing of the information with other facilities.

9 A copy of the Global TestNet guidance is attached in the annex to this document.

Action requested of the Committee

10 The Committee is invited to take note of this information.

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ANNEX

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

Global TestNet MGPS Guidelines – Rev0
Approved in Busan 5th November 2024

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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."
  Note: this guideline does not include surface treatments like coatings and paints.
- **Representative structures:** These are the experimental mimic sea chests, gratings and sea valves used in test rigs required to deliver this method.
- **Test Rig:** the complete experimental setup, which houses the representative structures (e.g. the replica of internal piping or sea chests), the MGPS being tested, and the water handling infrastructure (e.g. pumps).
- **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 be 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.

GENRAL 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.

- 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. The representative geometries are designed to mimic the sea chests, the main sea valve and first 2 m of internal pipework of a ship, see Figure 1.

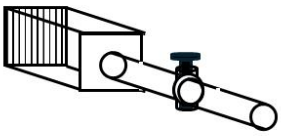

Figure 1: Representative structure of a sea chest, pipe and sea valve. Please note the reduced scale to allow for experimental replication in the test.

- 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.

- The following endpoints should be considered:

- *Measure the percentage cover of fouling on the bars / grills of the sea chest (i.e. what percentage of each section is fouled to a biofouling rate as described in Table 1 of the 2023 biofouling guidelines).*
- *Measure the percentage cover of fouling on a defined area of the walls of the sea chest away from the edges (i.e. mark out a 15cm² area on the side, bottom and top panel of the sea chest and assess the percentage of fouling in these areas). Care should be taken during the quantification procedure not to disturb the biofouling.*
- *Describe the visibility through a 30cm long optically clear (transparent) section of pipe downstream of the sea chest (i.e. clear, partially obscured, fully obscured by biofouling).*
- *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 does not completely stop the flow, the test is failed.*

- The minimum test duration should ensure that the fouling rate of each control has reached at least rating 3 (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).
- 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 not 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) are described according to the IMO Biofouling Guidelines, with a successful result being determined as the representative test geometries not exceeding biofouling rating two below that of the static control.

- 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.

EXPERIMENTAL SETUP AND TEST RIG DESIGN REQUIREMENTS

Key Requirements of the rigs

- 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:

    - The test rig should 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

- The representative structures are the test pieces that are used to simulate niche areas of a ship, and they provide the substrate on which the biofouling accumulation will be measured on during the test cycles. The representative structures should ideally be fabricated from suitable non-toxic materials. They consist of three separate parts fitted together:

    - 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.

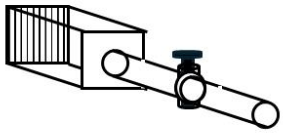

Figure 2: An example of a representative geometry for a sea chest with 2 metres of pipework and a sea valve.

- As a minimum, eight identical sets of representative geometries and water supply systems will be used for each rig/test to serve as:

    - Static control line (no MGPS treatment) x1
    - Static test line (with MGPS treatment) x3
    - Dynamic control line (no MGPS treatment) x1
    - Dynamic test line (with MGPS treatment) x3

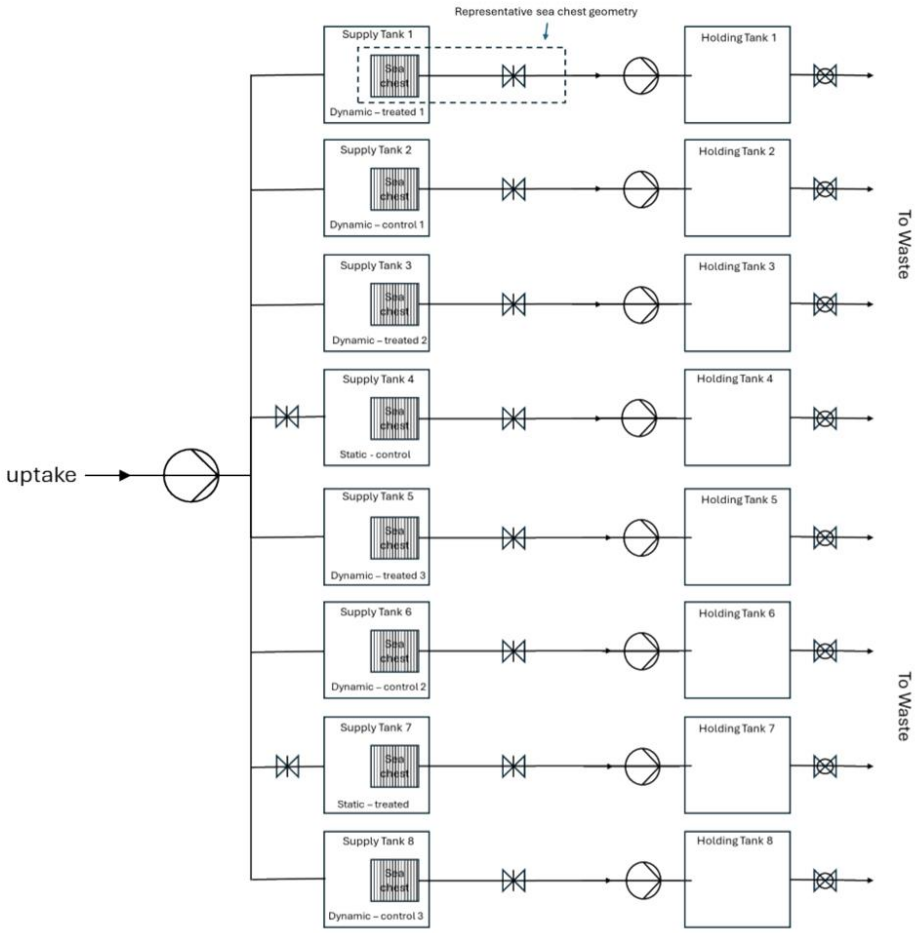

Figure 3: Plan view of a potential MGPS test rig showing the placement of the representative sea chest structure in each test channel.

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 enable the operator to safely access the representative geometries to perform image and data capture at weekly, bi-weekly and monthly intervals during the test, together with essential maintenance during the test.

The test rig must be capable of housing environmental data loggers capable of measuring and logging the parameters described in Table 2 to provide time series data in the test geometries. 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 the MGPS.

Water Supply

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

- worst case static conditions with very low water movement through the representative geometries (Static Test Line), and

- under dynamic flow conditions which simulate the expected flow rate and water exchange 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

- The technology used by the testing facility to pump the water through the different lines should be evaluated and designed to minimize the impact of biofouling organisms, thus ensuring a better comparability of the testing conditions. The following parameter should be taken into account when evaluating the design of the pumping structure:

  - Pumping rates, pressure, type of pumps (diaphragm, rotary, piston, centrifugal…) and valves.

  Test facility should demonstrate its ability to pump water into the holding systems, and still meet the minimum biofouling coverage requirement.

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 1. Sampling Requirements

Parameter	Sampling frequency
Temperature	Continuously
Salinity	Continuously
Flow rate	Continuously
Turbidity (UV MGPS only)	Continuously
Active substances if relevant (e.g., chloride, copper ions)	Monthly or more frequently if necessary
POC/DOC (these affect chlorine and UV efficacy)	Monthly or more frequently if necessary
Disinfection byproducts (if relevant)	Monthly or more frequently if necessary
Biofouling accumulation on representative geometry area and pipe	Monthly or more frequently if necessary

Biofouling accumulation on the sea value	At the end of the test period

Fouling Monitoring Requirements

- Fouling accumulation during the trial should be recorded by the test facility monthly or more frequently if necessary by staff who are trained and experienced in measuring biofouling.
- Biofouling will be measured by either:
    - taking digital images of the areas defined below and conducting standardised image analysis to accurately determine percentage cover, or
    - by making in-situ visual estimates of biofouling rating according to Table 1 in the IMO Biofouling Guidelines.

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