
**Ships and marine technology —
Bioassay methods for screening anti-
fouling paints —**

Part 1:
General requirements

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 2, *Marine environment protection*, in collaboration with Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

A list of all parts in the ISO 21716 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Anti-fouling paints that contain biocides are widely used to prevent fouling of ship hulls by marine organisms. Effective anti-fouling technologies are critical to maintaining the fuel consumption efficiency of ships, minimizing the release of greenhouse gases and other hazardous air pollutants, and also for minimizing the possible translocation of aquatic species through maritime trade. The evaluation of anti-fouling paints is generally undertaken by adopting a tiered approach, whereby paint manufacturers use a battery of laboratory, raft, patch tests and full vessel trials. Raft, patch tests and full vessel trials are generally conducted over extended periods of time and are predominantly relied upon for the prediction of coating performance when used commercially on in-service ships.

The results of raft, patch test and full vessel trials (field testing) can be used as part of the regulatory process for pesticidal or biocidal products in certain countries in order to demonstrate the efficacy of an anti-fouling paint. Laboratory testing alone is recognized as being unable to predict in-service performance of efficacy. For example, guidance published by the European Chemical Agency (ECHA) on the assessment and evaluation of efficacy for anti-fouling products states clearly that laboratory testing of individual anti-fouling paints is not undertaken as it is not considered to be a realistic evaluation of the product; field testing, which permits anti-fouling products to be tested under similar operating conditions and stresses as those encountered when the anti-fouling products are in service is routinely undertaken instead (see Reference [6]).

Whilst laboratory tests are unable to reliably predict in-service coating performance, they have merit in the screening of experimental coatings for further evaluation during the research and development process.

Reproducible objective data obtained by following standardized screening methods, independent of the test location or the season, can be a useful tool to support the selection of anti-fouling paints for higher tier testing, e.g. raft or ship tests. ISO 21716 provides a compilation and description of *in vitro* bioassay methods intended to aid the process of screening anti-fouling paints prior to higher tier raft or ship tests. Toxicological screening methods included in each part of ISO 21716 can be used for such purposes as early decision-making in research and product development, rapid feedback on potential toxicological concerns, or for the preliminary assessment of anti-fouling paints. For instance, ISO 21716 provides information on methods that can be used to screen anti-fouling paints in order to determine whether to continue development of an experimental paint and/or a product that contains a particular ingredient, or to determine whether to take on the cost of performing the remaining tiers within a complete tiered-testing strategy.

ISO 21716 provides screening bioassays related to certain common genera of fouling organisms, namely barnacles, mussels and algae. These screening tests are relatively simple and rapid laboratory tests that can be performed to provide an indication of the toxicity of a painted surface towards selected test organisms. The screening tests described in each part of ISO 21716 can be used as part of a tiered approach to predict the ability of an anti-fouling coating to prevent fouling on ships. Alternatively, to prevent the translocation of invasive marine species by progressively involving subsequent semi-field (e.g. raft panels) and field testing (e.g. ship trials). On their own, the screening tests described in each part of ISO 21716 do not reliably predict the ability of an anti-fouling coating to prevent fouling on ships or the translocation of invasive marine species.

ISO 21716 is not intended to provide a list of validated tests for testing the efficacy of anti-fouling; this can be covered in regulations. It is not intended to provide a list of validated tests for this purpose, nor for predicting the ability of a fouling control paint to prevent fouling on ships or to prevent the translocation of invasive marine species.

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Ships and marine technology — Bioassay methods for screening anti-fouling paints —

Part 1: General requirements

1 Scope

This document specifies general requirements and common specifications for preparing and aging panels coated with anti-fouling paint to perform laboratory bioassay screening tests against specified organisms. Such tests are given in the other parts of the ISO 21716 series, with which this document is intended to be used.

This document is applicable to all anti-fouling paints that prevent or deter the attachment and growth of sessile organisms on a surface through chemical or biological means.

It is not applicable to the following:

- coatings that deter or prevent fouling solely by physical means such as biocide-free foul release paints;
- anti-fouling methods used for controlling harmful marine organisms and pathogenic organisms in ships' ballast water and sediments according to IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004^[2].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 1513, *Paints and varnishes — Examination and preparation of test samples*

ISO 21716-2, *Ships and marine technology — Bioassay methods for screening anti-fouling paints — Part 2: Barnacles*

ISO 21716-3, *Ships and marine technology — Bioassay methods for screening anti-fouling paints — Part 3: Mussels*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

**3.1
aging**

providing the *test group* (3.9) with a surface condition that is more representative of the expected in-service surface condition of an *anti-fouling paint* (3.2) than a freshly applied paint surface by exposure to dynamic and/or static immersion in *natural seawater* (3.8) or *artificial seawater* (3.3)

**3.2
anti-fouling paint**

paint containing *biocides* (3.4) specifically designed to prevent or deter the attachment and growth of sessile organisms on a hull surface through chemical or biological means

**3.3
artificial seawater**

mixture of water and salts to mimic the properties of natural seawater

Note 1 to entry: Water prepared from the mixtures of salts described in ISO 15181-1, ISO 10253, ISO/TS 20787, or ASTM D 1141-98, and water prepared from commercially available proprietary artificial seawater salt mixtures have been found to be generally available.

**3.4
biocide**

substance having general or specific action such as mortality, growth inhibition, or repellancy, on sessile organisms, used in *anti-fouling paints* (3.2), for the prevention of attachment of sessile organisms

Note 1 to entry: Also called biocidally active substance, active ingredient or anti-foulant.

**3.5
biofilm**

layer of microscopic organisms such as bacteria, diatoms and the slimy extracellular polymeric substances they produce on the *test surface* (3.12)

**3.6
control group**

replicate *control panels* (3.7) prepared with the same specification and under the same conditions for confirmation of reproducibility of the test

**3.7
control panel**

panel that has no intended or expected ability to prevent or deter the attachment and growth of sessile organisms on its surface by chemical, biological or physical means

Note 1 to entry: An uncoated polyvinyl chloride or other inert plastic plate, or a panel coated only with anti-corrosive paint(s) has been found to be generally suitable.

**3.8
natural seawater**

water taken from the sea of sufficient quality to rear *test organisms* (3.10)

**3.9
test group**

replicate *test panels* (3.11) prepared with the same specifications and under the same conditions for confirmation of reproducibility of the test

**3.10
test organism**

marine organism used in the bioassay

**3.11
test panel**

panel coated with the *anti-fouling paint* (3.2) to be tested in the bioassay

3.12**test surface**

surface of a *test panel* (3.11) or *control panel* (3.7) to be investigated in the test

4 Preparation of the test panels**4.1 Test procedure — General**

The test procedure consists of the following steps, as shown in [Figure 1](#):

- selecting a material for substrates;
- applying the anti-fouling paint to replicate test panels;
- aging the panels in test seawater, as specified in each part of the ISO 21716 series, and;
- pre-treating the panels prior to bioassay testing.

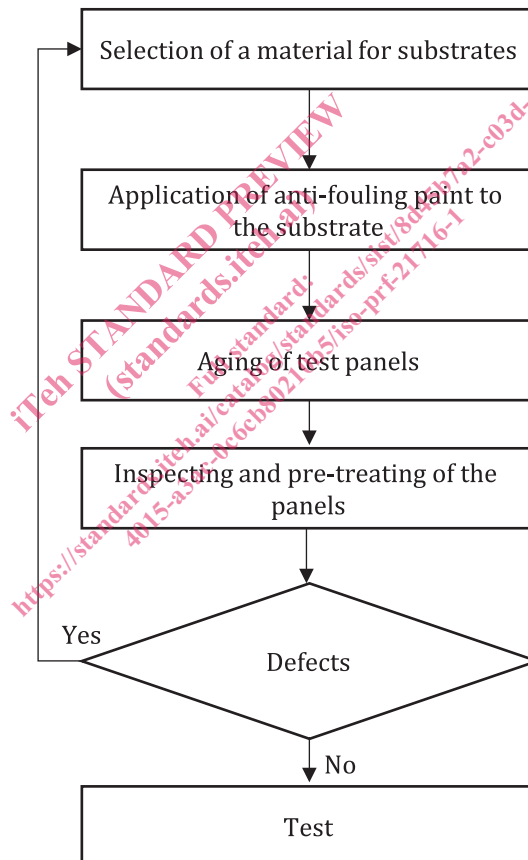


Figure 1 — Test procedure for preparing the test panels

4.2 Selection of a material for substrates

The material for the substrates of the test panels shall be non-conductive and suitable for immersion in seawater. The size of the test surface shall meet the requirements specified in the relevant part of the ISO 21716 series.