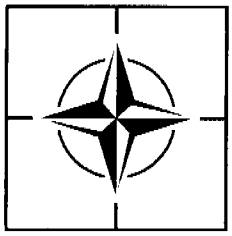

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PERFORMANCE REQUIREMENTS FOR UNDERWATER HULL PAINT SYSTEMS

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Juan A. MORENO
Vice Admiral, ESP(N)
Director, NATO Standardization Agency

ORIGINAL

NATION	SPECIFICATION RESERVATIONS

RECORD OF CHANGES

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CHAPTER 1 INTRODUCTION

The aim of this Allied Engineering Publication (AEP) is to establish the minimum requirements for the protection of underwater hulls from corrosion and attachment of marine organisms, or “biofouling”, exclusive of slime layers. This is a specification for the approval of paint systems and paints which have the following functions:

- corrosion control (≥ 15 years)
- biofouling control (up to 12 years)

CHAPTER 2 SCOPE

This AEP deals with the performance requirements for biofouling and corrosion protection by Underwater Hull Paint Systems (UHPS) applied to ships hulls subject to seawater immersion.

This AEP applies to UHPS intended to provide corrosion control for a minimum of 15 ears, for structures exposed to the corrosion category Im2 in accordance with ISO 12944-2.

This AEP applies to short-life (2-3 years), intermediate-life (4-7 years), and long-life (8-12 years) antifouling coating systems for ships underwater hulls and related structures subject to seawater immersion, where the corrosion category is Im2 as described in ISO 12944-2 and references cited therein.

This AEP addresses:

- Laboratory and field performance test methods for the assessment of durability, resistance to marine biofouling, and corrosion protection afforded by the underwater hull paint system,
- Evaluation criteria for performance testing,
- Test methods for the verification of the individual components of the underwater hull paint system,
- Acceptance criteria

It is intended that UHPS qualified under this AEP will be applied in accordance with AEP 59 in order to reach the desired service life.

CHAPTER 3 NORMATIVE REFERENCES

NATO AEP 59 Application Process for Optimum Paint and Coating Systems' Performance
ISO 1247 Aluminium pigments for paints
ISO 1248 Iron oxide pigments - Specifications and methods of test
ISO 1514 Paints and Varnishes - Standard Panels for Testing
ISO 2114 Plastics (Polyester Resins) and Paints and Varnishes (Binders) - Determination of Partial Acid Value and Total Acid Value
ISO 2409 Paints and Varnishes - Cross-Cut Test
ISO 2808 Paints and Varnishes - Determination of Film Thickness
ISO 2810 Paints and Varnishes - Natural Weathering of Coatings – Exposure and Assessment
ISO 2811 Paints and Varnishes - Determination of Density
ISO 2812 Paints and Varnishes - Determination of Resistance to Liquids
Part 1: General Methods
Part 2: Water Immersion Method
ISO 3001 Plastics. Epoxy compounds. Determination of epoxy equivalent
ISO 3233 Paints and Varnishes - Determination of Percentage Volume of Non-Volatile Matter by Measuring the Density of a Dried Coating
ISO 3251 Paints, Varnishes and Plastics - Determination of Non-Volatile-Matter Content
ISO 3270 Paints and varnishes and their raw materials - Temperatures and humidities for conditioning and testing
ISO 3549 Zinc dust pigments for paints - Specifications and test methods
ISO 3679 Determination of Flash Point - Rapid Equilibrium Closed Cup Method
ISO 3682 Binders for paints and varnishes. Determination of acid value. Titrimetric method
ISO 4618 Paints and varnishes - Terms and definitions
Part 1: General Terms
Part 2: Special Terms Relating to Paint Characteristics and Properties
Part 3: Surface Preparation and Methods of Application
ISO 4624 Paints and Varnishes – Pull-Off Test for Adhesion
ISO 4628 Paints and Varnishes - Evaluation of Degradation of Coatings - Designation of Quantity and Size of Defects, and of Intensity of Uniform Changes in Appearance
Part 1: General Introduction and Designation System
Part 2: Assessment of Degree of Blistering
Part 3: Assessment of Degree of Rusting
Part 4: Assessment of Degree of Cracking
Part 5: Assessment of Degree of Flaking
Part 6: Rating of Degree of Chalking by Tape Method
Part 8: Assessment of Degree of Delamination and Corrosion around a Scribe
ISO 4629 Paints and varnishes - Determination of hydroxyl value
ISO 6270 Paints and varnishes - Determination of Resistance to Humidity (Continuous Condensation)
ISO 6745 Zinc phosphate pigments for paints - Specifications and methods of test

ISO 8044 Corrosion of Metals and Alloys – Basic Terms and Definitions
ISO 8501 Preparation of Steel Substrates before Application of Paint and Related Products – Visual Assessment of Surface Cleanliness
Part 1: Rust Grades and Preparation Grades of Uncoated Steel Substrates and of Steel Substrates after Overall Removal of Previous Coatings
ISO 8502 Preparation of Steel Substrates before Application of Paint and Related Products – Tests for the Assessment of Cleanliness
Part 3: Assessment of Dust on Steel Surface Prepared for Painting (Pressure-Sensitive Tape Method)
Part 4: Guidance on the Estimation of the Probability of Condensation Prior to Paint Application
Part 6: Extraction of Soluble Contaminants for Analysis. The Bresle Method
Part 9: Field Method for the Conductometric Determination of Water-Soluble Salts
ISO 8503 Preparation of Steel Substrates before Application of Paint and Related Products – Surface Roughness Characteristics of Blast Cleaned Substrates
Part 2: Method for the Grading of Surface Profile of Abrasive Blast-Cleaned Steel - Comparator Procedure (ISO 8503-2)
ISO 8504 Preparation of Steel Substrates before Application of Paints and Related Products — Surface Preparation Methods
Part 1: General Principles
Part 2: Abrasive Blast Cleaning
Part 3: Hand and Power-Tool Cleaning

ISO 9117 Paints and Varnishes – Determination of Through-Dry State and Through-Dry time – Method Test
ISO 9227 Corrosion Tests in Artificial Atmospheres-Salt Spray Tests
ISO 9514 Paints and Varnishes - Determination of the Pot-Life of Liquid Systems
ISO 10601 Micaceous iron oxide pigments for paints - Specifications and test methods
ISO 11507 Paints and Varnishes – Exposure of Coatings to Artificial Weathering – Exposure to Fluorescent UV and Water
ISO 11890 Paints and Varnishes - Determination of Volatile Organic Compounds
ISO 11908 Binders for Paints and Varnishes - Amino Resins - General Methods of Test
ISO 11909 Binders for Paints and Varnishes - Polyisocyanate Resins - General Methods of Test
ISO 11998 Paints and Varnishes - Determination of Wet Scrub Resistance and Cleanability of Coatings
ISO 12944 Paint and Varnishes - Corrosion Protection of Steel Structures by Protective Paint Systems
Part 1: General introduction
Part 2: Classification of environments
Part 3: Design consideration
Part 4: Types of surface and surface preparation
Part 5: Protective paint systems
Part 6: Laboratory performance test methods
Part 7: Execution and supervision of paint work
Part 8: Development of specifications for new work and maintenance

ISO 14680 Paints and varnishes -- Determination of pigment content
Part 1. Centrifuge method
Part 2 . Ashing method
ISO 15181 Paints and Varnishes – Determination of Release Rate of Biocides from Antifouling Paints
Part 1: General Method for Extraction of Biocides
Part 2: Determination of Copper-Ion Concentration in the Extract and Calculation of the Release Rate
ISO 15711 Paints and Varnishes – Determination of Resistance to Cathodic Disbonding of Coating Exposed to Sea Water
ISO 16862 Paints and Varnishes – Evaluation of Sag Resistance
ISO 20340 Paints and Varnishes – Performance Requirements for Protective paint systems for offshore and related structures
ASTM D 2372 Standard Practice for Separation of Vehicle from Solvent-Reducible paints
ASTM D 2572 Standard Test Method for Isocyanate Groups in Urethane Materials or Prepolymers
ASTM D 2621 Standard Test Method for Infrared Identification of Vehicle Solids from Solvent-Reducible Paints
ASTM D 3623 Standard Test Method for Testing Antifouling Panels in Shallow Submergence
ASTM D 3960 Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D 4938 Standard Test Method for Erosion Testing of Antifouling Paints Using High Velocity Water
ASTM D 5479 Standard Practice for Testing Biofouling Resistance of Marine Coatings Partially Immersed
ASTM D 6990 Standard Practice for Evaluating Biofouling Resistance and Physical Performance of Marine Coating Systems
ASTM F 1130 Standard Practice for Inspecting the Coating System of a Ship
SSPC SP 1 Solvent Cleaning

CHAPTER 4 DEFINITIONS

For the purposes of this AEP, the following terms and definitions apply.
NOTE: Some of the definitions have been taken from ISO 8044:1999, ISO 12944 and ISO 4618, as indicated.

4.1. ABLATIVE PAINT

A paint which is slowly worn away primarily by dissolution of the resin binder and physical erosion of flowing water, exposing fresh paint material and the biocide(s) it normally contains.

4.2. ANTICORROSIVE (A/C) PAINT

For a UHPS, this refers to the base coat(s), typically epoxy formulations, first applied to the metal structure before application of the antifouling paint (or tie-coat).

4.3. ANTIFOULING (A/F) PAINT (SEE ALSO "FOUL RELEASE")

The outermost coat(s) applied to ships' hulls to resist surface attachment by marine biofouling organisms, particularly the larger ("macro") species such as barnacles, tubeworms and encrusting bryozoa, which can adversely impact vessel performance.
NOTE : Among marine paint technologists, the term is often taken to refer specifically to those paints that release biocides (toxins) during service use; for nonablative paints that are free of toxic biocides, the specific term "foul release paint" is often used.

4.4. BIOCIDE

As applied to antifouling paint systems, a chemical compound that is toxic to one or more types of hull fouling organisms. Present in ablative, self-polishing, and nonablative leaching antifouling topcoats, either as a single compound or multiple compounds; if the latter, the term co-biocides is often used to refer to the two or more biocides present.

4.5. BIOFOULING

Attachment by marine organisms to the immersed surfaces. The marine paints community is generally most concerned with the large ("macro") and hard-shelled species which can affect ship performance, such as barnacles, tubeworms and encrusting bryozoa, as opposed to smaller "soft" species and slimes (e.g. algae, bacteria) which are less deleterious to ship performance.

4.6. CLEANED SURFACE (CLEANLINESS)

A surface from which the contaminants have been removed to a specified level [ISO 8504-3].

4.7. COAT

A continuous layer of a coating material resulting from a single application [ISO 4618].

4.8. CORROSION

Physico-chemical interaction between a metal and its environment that results in changes in the properties of the metal and that may often lead to impairment of the function of the metal, the environment or the technical system of which these form a part [ISO 8044].

4.9. CUPROUS OXIDE [ALSO COPPER(I) OXIDE]

A metal oxide, supplied in fine powder form, commonly added to antifouling paints as a biocide. Particularly active against hard-shelled biofouling marine organisms such as barnacles. See Biocide.

4.10. DRY FILM THICKNESS (DFT)

The thickness of a paint remaining on the surface when the paint has hardened.

4.11. DURABILITY

The expected life of an underwater hull paint system to the first major maintenance painting [ISO 12944-1]. Durability in accordance with ISO 12944-1 concerns only the A/C performances of the paint system.

4.12. EROSION

The physical process by which ablative paint surface material is removed in service, as a result of the shear force of the water acting on the hull, often in conjunction with physico-chemical interactions between the paint and the seawater (e.g. resin hydrolysis/solubilization).

4.13. FOUL RELEASE (SOMETIMES CALLED “EASY RELEASE”)

Paints free of releasable toxic (biocidal) substances, which instead rely on surface properties designed to resist strong adhesion by fouling organisms.

4.14. IM-2

This is the category corresponding to sea or brackish water environment as defined by ISO 12944-2.

4.15. MATERIAL SAFETY DATA SHEET (MSDS)

A document designed to provide information regarding the health and safety aspects of a paint product or thinner
NOTE: The MSDS typically includes information concerning generic material identification, hazardous ingredients, physical data, fire and explosion data, health hazards, reactivity data, spill or leak procedures, special protection requirements, and other special precautions. Material Safety Data Sheet format is in accordance with the regulation of the nation.

4.16. NOMINAL DRY FILM THICKNESS (NDFT)

The dry film thickness specified for each coat and the whole paint system to achieve the required durability [ISO 12944-5].

4.17. NOMINAL WET FILM THICKNESS (NWFT)

The wet film thickness, for each coat that corresponds to the specified NDFT.

4.18. NONABLATIVE PAINT

A paint which does not lose resin material during service use in seawater immersion. Usually encountered with foul release paint systems, or biocide diffusion systems.

4.19. PAINT

A pigmented coating material in liquid, in paste or powder form that, when applied to a substrate, forms an opaque film having protective, decorative or specific technical properties [ISO 4618].

4.20. QUALIFICATION

A process for the evaluation of underwater hull paint systems using test criteria which allow the selection of suitable paint systems for distinct environmental exposure conditions

4.21. PRODUCT DATA SHEET (PDS) OR TECHNICAL DATA SHEET (TDS)

A document designed to provide information on a specific paint product
NOTE: The type of information includes product uses, features, service properties, application properties, application instructions, packaging information, and information on storage and handling.

4.22. REPAIRABILITY

Amenability of paint system to be repaired by maintenance paint system, including repair of anticorrosive paint and topcoat.

4.23. RECOATABILITY

Ability of paint dry film (generally topcoat) to be overcoated, without compatibility failure.

4.24. SELF-POLISHING PAINT

A paint which relies on chemical reaction(s) between the resin binder and seawater for removal of surface material, typically resulting in more even and controlled material removal than is the case for ablative paints, resulting in better self-smoothing (reduced roughness).

4.25. SELF-SMOOTHING: SEE SELF-POLISHING PAINT

4.26. SHELF LIFE

The period from the date of manufacture during which the paint can be transported and/or stored in undamaged and unopened packaging without any influence on its application or performance providing the ambient conditions are within the limits recommended by the paint manufacturer, or otherwise agreed.

NOTE: After exceeding this period, the paint is subject to reinspection.

4.27. SUBSTRATE

The surface to which the coating material is applied or is to be applied [ISO 4618]

4.28. TIE-COAT

A paint applied over the outermost anticorrosive base coat, over which antifouling paint is then applied. Used when needed, to enable adequate adhesion of the antifouling paint.

4.29. TOXICOLOGICAL RISK

The health risk to humans, or to the environment, posed by chemical substances.

NOTE: Workplace toxicological risks are encountered wherever uncured paint components (i.e., liquid resin paint precursors) are handled. For antifouling paints containing releasable biocides, environmental toxicological risks are also present (e.g. estuarine/sediment pollution, carcinogenic/mutagenic/teratogenic effects on marine life). Cured antifouling topcoats with biocides may also pose a workplace toxicological risk, for example through physical contact with skin or other tissue.

4.30. TRIBUTYLTIN (TBT)

A member of the organotin family of chemical compounds. Originally used as a dispersed biocide in soluble matrix and diffusion coatings, then as the biocidal component of the copolymer in self-polishing antifouling paints. Application of paints containing TBT is now banned internationally, and vessels already coated with TBT-containing antifouling paints will require removal or sealing (over-coating) of these TBT paints by the end of 2007. See Biocides.

4.31. UNDERWATER HULL PAINT SYSTEM (UHPS)

A system comprised of an anticorrosive paint system (one or more coats), a tie-coat (when necessary), and an antifouling (including foul release) paint system (also one or more coats).

4.32. VOLATILE ORGANIC COMPOUND (VOC)

The mass of the volatile organic compounds present in a paint material, as determined under specific conditions. [ISO 11890 adapted from ISO 4618-1]

NOTE 1: The properties and the amount of the compounds to be taken into account will depend on the field of application of the paint material. For each field of application, the limiting values and the methods of determination or calculation are stipulated by regulations or agreement.

NOTE 2: Under certain US governmental legislation, the term VOC is restricted solely to those compounds that are photochemically active in the atmosphere (see ASTM D 3960). Any other compound is then defined as being an exempt compound.

CHAPTER 5 FIELD OF APPLICATION

The field of application for which this Publication is developed is characterised by:

- the type of structure,
- the environment,
- the durability requirement,
- the type of application,
- the type of substrate and surface preparation,
- the type of paints.

5.1. TYPE OF STRUCTURES

This Publication concerns structures – underwater hulls of ships – made of steels, other metallic materials, Fibre Reinforced Plastic (FRP), or other non-metallic materials. Hull structures covered by this AEP include but are not limited to struts, rudders, and shafts.

5.2. TYPE OF ENVIRONMENT

The environments relevant to this AEP include all open-ocean and estuarine waters in which seagoing vessels under the jurisdiction of this AEP operate. The ship hull paints described by this AEP undergo continuous and, for the waterline area of hulls, intermittent immersion in such waters.

5.3. SERVICE LIFE AND DURABILITY

The A/C shall be of high durability, with a service life of no less than fifteen (15) years, in accordance with ISO 12944-1. During this period, general A/F topcoat applications and localized repairs (such repairs to include all layers of the UHPS where necessary) are carried out. These repairs are considered to be minor maintenance.

The protection of the paint system against marine biofouling shall be specified to last for 2-3 years, 4-7 years, or 8-12 years, depending on the intended service of the vessel (operating rate and speed profile).

5.4. APPLICATIONS

The applications covered by this AEP are new building application or equivalent (total removal of pre-existing paints). The new building paint system must be adapted to maintenance procedures such as localized repairs (e.g. due to mechanical damages) and general topcoat application.

No mechanical surface preparation shall be required for the application of the antifouling paint for maintenance. Water washing to remove fouling and hydrolysed layer shall be carried out.

Maintenance shall be carried out using a compatible paint maintenance system.

5.5. TYPE OF SUBSTRATE AND SURFACE PREPARATION

All ship hull substrates to be coated with antifouling paint systems compliant with this AEP shall be identified according to table 5-1.

Substrate Designation	Description of Substrate
S	Steel
A	Aluminium
F	Fibre Reinforced Plastic
N	Other Non-metallic (wood, rubber, etc)

Table 5-1: Substrate Identification

5.5.1. Cleanliness

The description of surface preparation covers cleanliness, levels of contamination and roughness. The surface preparations generally used for the different types of substrates are identified in table 5-2.

Nature of substrate	Surface preparation	Standardization
Steel and steel alloys	A Sa 2½	ISO 8501-1
Aluminium and aluminium alloys	Sweep blast and optional solvent wipe	n/a
Fibre reinforced plastic	Sweep blast to remove gloss	n/a
Other Non-metallic	Sweep blast and optional solvent wipe	n/a

Table 5-2 Substrate Cleanliness

5.5.2. Contamination

For all types of substrate, the minimum level of cleanliness (contamination) before paint application is equal to the followed criteria:

Criteria	Minimum level	Standardization
Dust	Intensity : < 2 (Figure 1, ISO 8502-3) Size : ≤ 2 (Board 1, ISO 8502-3)	ISO 8502-3(1)
Moisture (probability of condensation)	Relative humidity ≤ 85 % Substrate temperature ≥ [dew point + 3°C]	ISO 8502-4(1)
Oils and greases	No visual indication	SSPC SP-1
Soluble salts	≤ 5 µg/cm2 (chloride equivalent)	ISO 8502-6/9(1)

(1) Theses specifications are standardized only for steel surfaces but may be used as a reference on other types of substrates commonly encountered in building naval vessels (FRP, aluminium alloys, etc.).

Table 5-3: Substrate Contamination

5.5.3. Roughness

The grade used is MG (Medium Grit) of the comparator procedure defined by ISO 8503-2.

5.6. TYPE OF PAINT PRODUCT

The generic types of anticorrosive paint used in paint systems for the protection of steel structures are described in, but not limited to ISO 12944-5.

Individual component paints comprising the paint system may be applied by brush, roller, or spray and dry at ambient temperatures in normal shipyard condition, within the parameters specified by the paint manufacturer for each paint.

All antifouling paints compliant with this AEP shall be classified according to table 5-4, based on their mechanism of antifouling activity:

Paint Type	Mechanism of Antifouling Action
R	Paint systems having topcoats that ablate or self-polish, releasing biocide(s) in the process
D	Paint systems having topcoats that do not ablate or self-polish, but release biocide(s) by diffusion (“leaching”) from the topcoat
I	Paint systems having topcoats that do not ablate or self-polish, nor contain releasable biocide

Table 5-4: Antifouling Types

All antifouling paint systems compliant with this AEP shall be classified according to the presence and nature of the biocide they contain, in accordance with table 5-5.

Biocide Designation	Description of Biocide
1	Copper and/or its compounds; high copper release rate (≥ 20 µg·cm-2 ·day-1)
2	Copper and/or its compounds; low copper release rate (<20 µg·cm-2·day-1)
3	Biocide systems containing no copper (“copper-free”)
4	No biocides in the paint system (“biocide-free”)

Table 5-5: Biocide Types

CHAPTER 6 REQUIREMENTS FOR QUALIFICATION

Requirements for paint systems submitted for the qualification approval are described in the following items:

- Documentation requirements
- Basic requirements
- Qualification tests
- Paint identification

For the proposed paint system, the manufacturer shall prepare and submit documents in accordance with § 6.1.

Basic requirements for the paint system submitted for the qualification are listed in § 6.2; characteristics of paint system shall be in accordance with them.

The underwater hull paint systems shall be performance tested in accordance with § 7 and the individual paints comprising the system shall be identified in accordance with § 8.

The chemical composition of the paints in the underwater hull paint system shall be controlled during and after the qualification process. Any change shall be noted and justified by the manufacturer proving that such changes do not negatively affect the long-term properties of the material (see § A 1-4). A new data sheet shall be submitted for each modified paint.

6.1. DOCUMENTATION REQUIREMENTS

At the time of submission for qualification the UHPS shall be identified by unique nomenclature (system name, alphanumeric identification) and also each individual product constituting the system shall be identified by unique nomenclature (product name, alphanumeric identification, index of product formulation, chemical nature, colour, nominal dry film thickness for each coat in µm).

The manufacturer shall submit technical product data containing all of the following information and documents:

▪ Technical data sheet of UHPS (see § A 1-1)
▪ Product information for each paint component of the paint system (see § A 1-2)
▪ Use references (see § A 1-3)

6.2. BASIC REQUIREMENTS

6.2.1. General objectives

UHPS submitted for qualification shall have:

a. Anticorrosive performance throughout service life in seawater immersion category (Im2) of ISO 12944-2 for a minimum service life of 15 years, without need for repair beyond that allowed in § 5.3.

b. Antifouling performance for 2-3 years, 4-7 years, or 8-12 years, depending on the intended service of the vessel (operating rate and speed profile)

c. During the service life, it is presumed that one or more coats of A/F paint will be re-applied at regular intervals. The A/F paint shall be amenable to such repair/replacement procedures.

d. Localized repair of A/F paint shall be practically achievable without mechanical surface preparation.

e. If applicable, the vendor shall indicate the process for underwater hull cleaning, and this information shall be included with the product technical data (§ A.2). Unless approved prior to testing of the A/F paint, mechanical cleaning shall not be permitted as any part of the performance evaluation process. Note: Underwater hull cleaning is prohibited in some countries.

6.2.2. Requirements

Unless stated otherwise, requirements stated in this section shall apply to each individual component paint of the UHPS.

Paint systems submitted for qualification shall meet the following requirements:

6.2.2.1. Paint system architecture

The UHPS shall include the application of two or more coats of anticorrosive paint, of colours which are clearly distinguishable from one another, as well as from the antifouling topcoat colours. The minimum NDFT of the anticorrosive paint shall be 250µm (excluding zinc-rich primer and tie-coat)

The number of individual coats of the antifouling topcoat to be applied shall be determined based on the service life of the paint system. The thickness of individual coats shall be in accordance with paint manufacturer’s technical data sheet.

6.2.2.2. Application conditions

Individual component paints constituting the UHPS shall dry in normal atmospheric conditions which are defined as:

a. Relative Humidity : ≤ 85 %,

b. Substrate temperature: at least 3°C above the ambient dew point,

c. Application temperature: not less than 5°C, no greater than 35°C.

No specific surface preparation between coats shall be required

(For qualification) Each paint shall be applicable with brush, roller, or spray, to a nominal dry film thickness (NDFT) of at least 1,5 times the specified NDFT without defects.

6.2.2.3. Safety, occupational health, and environmental impact

All component paints comprising the UHPS submitted shall be in compliance with the national regulations, minimum requirements for environment impact as given in table 6-1.

Criteria	Anticorrosive (and, when applicable, intermediate) Coats (1)	Antifouling Topcoats (1,2)
VOC (target)	250 g·L-1	400 g·L-1

Table 6-1: Environmental Impact Requirements

(1) For two component products, values are for the mixed and ready to use product
(2) Organotin biocides are prohibited from use as antifouling agents in the AF paint

6.2.2.4. Total Volatiles

The total volatile content of each component paint of the antifouling paint system, as determined by ISO 11890 or ASTM D 3960 (as appropriate), shall be reported with the product technical data (§ A.2), as an item separate from the volatile organic compound (VOC) content.

6.2.2.5. Flash Point

When determined in accordance with ISO 3679, flash point shall be no less than 21°C.

6.2.2.6. Shelf life

: Shelf life shall be at least 18 months for anticorrosive paint and at least 12 months for antifouling paint (on delivery).

6.2.2.7. Condition in container

Paints shall not exhibit on delivery or during shelf life: hard settling, skinning, corrosion of container, persistent foam after mix or other properties indicating unfitness for use. Water-based systems shall meet all of these requirements, and will not exhibit phase separation, evidence for biological growth, or putrefaction.

Paints shall readily mix with a mechanical mixer within five (5) minutes to a smooth uniform consistency, free of grit, seed, tough or gummy sediment, skins, hard pigment settling, and persistent foam.

6.2.2.8. In-container storage stability

When tested in accordance with § 7.2 and § B.3 Individual component paints comprising the UHPS shall satisfy the criteria for condition in container, as presented in the previous paragraphs.

6.2.2.9. Colour

The A/F paint shall be available in a range of colours, e.g. red, black, white, grey, blue.

6.2.2.10. Service life verification

Once a full hull ship trial is underway on an operational Navy vessel as described previously, the Navy will monitor paint performance to establish compliance with this AEP, and to verify the service life classification as described in § 5.3 (2-3, 4-7, or 8-12 years).

6.2.2.11. Cathodic protection compatibility

UHPS shall demonstrate cathodic protection compatibility.

6.2.2.12. Adhesion strength

Adhesion strength in accordance with Table 7-2.

CHAPTER 7 QUALIFICATION TESTS

7.1. PREPARATION AND CONDITIONING OF TEST PANELS

7.1.1. Test panels

Type, size, number, preparation and conditioning of test panels are in accordance with the ISO 12944-6 or ISO 20340 and the instructions of the manufacturer of paint material. If not otherwise agreed, the thickness of panels is 5 mm. These panels shall be steel, and in compliance with ISO 1514.

7.1.2. Surface preparation

The test panels shall be grit blasted to Sa 2½ (ISO 8501-1) using a non-metallic abrasive. The surface profile of test side of each panel shall correspond to MG class (Medium grit) as defined in ISO 8503-1 and checked with comparator as described in ISO 8503-2. Surface contaminant levels are in accordance with § 5.5.

7.1.3. Application and curing

The panels shall be coated by spraying and strictly in accordance with the latest manufacturer's written instruction.

NOTE: In circumstances where the antifouling paint system will not be applied to the entire immersed surface, those fouling-susceptible surfaces (typically the backside and edges) of test panels shall be sealed with an appropriate anticorrosive barrier paint, the details of which shall be agreed upon in advance by all concerned parties.

7.1.4. Dry Film Thickness (DFT)

For each layer, prior to overcoating, the DFT on test face panels shall be measured in accordance with ISO 2808 at a minimum of 5 positions (centre and corners, 15 to 20 mm from edges). Values of thickness shall be recorded as minimum, maximum and average.

7.1.5. Over-coating time

Over-coating time for each layer shall be conducted in accordance with the paint manufacturer’s instructions. Deviated over-coating time shall be agreed between parties involved and recorded in the test report.

7.1.6. Conditioning

The panels shall be conditioned under controlled temperature and humidity in accordance with ISO 3270. Deviations from standard conditions for sample curing and conditioning shall be clearly stated and justified in the test report.

7.1.7. Scribe line

Scribe lines, which are required to evaluate anticorrosive paint performance in Im2 corrosion environments, and when introduced into paint samples as described below (§ 7.3), shall cut through the underwater hull paint system down into the substrate.

A scribe line shall be made on the test panel using a scribing machine such as drill press with cobalt slot drills. In such a case, a 2 mm width is recommended for the drill

and shall be used for calculation of undercutting with the formula given in annex A of ISO 12944-6 (use W = 2 mm). In accordance with ISO 12944-6 annex A, these scribe lines shall be diagonal and at least 50 mm long and 20 mm from any edges.

7.2. PERFORMANCE TESTS

Before paint application on panels or ship hulls for performance tests, the applicability (suitability for application) and storage stability of paints are checked

7.2.1. Applicability

Each paint shall be applied with brush, roller, or spray, without runs and sags to vertical and smooth sheet metal with minimum area of 1 m², to achieve a nominal wet film thickness (NWFT) which will yield a nominal dry film thickness (NDFT) consistent with manufacturer's product data sheet (See § B.3).

7.2.2. Storage Stability

Paints shall not exhibit on delivery or during shelf life: hard settling, skinning, phase separation, corrosion of container, persistent foam after mix or other properties indicating unfitness for use. (see § A 2-3)

7.3. PERFORMANCE TESTS

The tests are detailed in Table 7-1.

PERFORMANCE TESTS							
	N°	Nature	Duration	Standard	A/C	A/F	UHPS
Laboratory Tests	1	Salt spray(1)	1440 h	ISO 9227 (neutral salt spray, paragraph 3.2.2)	x		
	2	Water condensation	720 h	ISO 6270	x		
	3	Sea water immersion	4200 h	ISO 2812-2			x
	4	Re-coatability and repairability	-	A 2-1			x
	5	Compatibility with cathodic protection	6 months	ISO 15711 method B(2) Initial holiday of 6 mm diameter	x		x
Natural Exposure	6	Static sea water immersion (A/F type R and D)	> 1 year (low, medium life) > 2 years (long life)	ASTM 3623 & 5479 A 2-4			x
	7	Alternating static immersion and dynamic flow (A/F type I)	Cycles TBD (low, medium life) Cycles TBD (long life)	A 2-4 & ASTM D 4938			x
	8	Hull patches (A/F type R, D and I)	Commercial ship : > 3 years (low, medium life) Government ship : > 2 years (low, medium life) > 5 years (long life)	A 2-5			x
Ship Trial	9	Full hull(3) (A/F type R, D and I)	Commercial ship : > 3 years (low, medium life) Government ship : > 2 year (low, medium life) > 5 years (long life)	A 2-6			x

(1) Scribe line for test N°. 1
(2) Method B using a magnesium anode
(3) UHPS applied in accordance with AEP-59

Table 7-1: Performance Tests Required

7.4. ACCEPTANCE CRITERIA

Acceptance criteria are identified in table 7-2.

ACCEPTANCE CRITERIA					
	NATURE OF TEST	Test required before and after Table 7-1 exposure N°	Level before qualification tests	Level after qualification tests	STANDARD
A	Pull-off adhesion test	1, 2	Pull-off value ≥ 4 MPa or ≥ 3 MPa for paint system with zinc rich primer (ZRP)	Pull-off value ≥ 50 % of original value No adhesive failure	ISO 4624
B	Pull-off adhesion test	3, 4	Pull-off value ≥ 1.5 MPa	Pull-off value ≥ 50 % of original value No adhesive failure	ISO 4624
C	Degree of delamination in scribe line	1	-	< 3 mm (scribing machine with 2 mm width)	ISO 4628-8 (paragraph 5.2.1)
D	Failures (rusting, blistering, cracking, peeling...)	1, 2, 3, 4, 5, 6, 7, 8, 9	No failure	No failure	ISO 4628
E	Fouling (barnacles, algae...)	see below	-	Biofouling resistance: Do not count biological slimes as fouling	
E.1	Static sea water immersion (R, D)	6	-	<10% of colonized surface	ASTM D 6990
E.2	Dynamic flow (I)	7	-	fouled surface area ≤ 25% at end of test period	ASTM D 4938 [Flow channel with natural seawater, flow velocities 10 and 15 m·s-1 (20kt and 30kt)] ASTM D 6990
E.3	Ship trial (R, D, I)	8, 9	-	fouled surface area ≤ 5% for types R, D; ≤ 15% for type I (after high-pressure, <20MPa, fresh-water washing)	ASTM D 6990
F	Cathodic disbondment	5	n/a	Holiday diameter < 20 mm (According to ISO 20340)	ISO 15711

Table 7-2: Acceptance Criteria

CHAPTER 8 PAINT IDENTIFICATION

Each paint constituting paint system submitted to the qualification process should be checked according to table 8-1 (the different values are given by the paint manufacturer).

Tests	Method reference	Expression of results ("x value")
Density	ISO 2811	x ± 0.05 g·cm-3 (1)
Solids content (% by weight)	ISO 3251	x ± 2.0 %
Ash content (% by weight)	ISO 14680-2 (900 ± 20 °C)	x ± 3.0 %
Pigment (including extender) and binder (% by weight)	ISO 14680-1 (solvent paint) ISO 3251 (waterborne paint)	x ± 2.0 %
Infrared spectra of binder	ASTM D2372 ASTM D2621	Compare with reference spectra
Functional pigments contents (% by weight): Aluminium Iron Oxide (red oxide) Micaceous iron oxide Zinc dust Zinc phosphate	 ISO 1247 ISO 1248 ISO 10601 ISO 3549 ISO 6745	 x ± 1.0 % x ± 1.0 % x ± 1.0 % x ± 1.0 % x ± 1.0 %
Characteristic index: Epoxy OH Acidic Amine Isocyanate	 ISO 3001 ISO 4629 ISO3682 ISO 11908 ISO 11909	 x % x % x % x % x %
Drying time: Dry to touch Hard time	ISO 9117	≤ x h ≤ x h
Flash point	ISO 3679	≥ x °C
Pot life	ISO 9514	≥ x h
VOC: Anticorrosive paint Topcoat	 ISO11890-1, -2	 ≤ x g/L ≤ x g/L
Erosion rate	TBD by paint manufacturer	µm/yr at x knots
Biocide release rates	TBD by paint manufacturer	x µg·cm-2·day-1
Biocide content	TBD by paint manufacturer	weight percent

Table 8-1:Paint Identification Tests

NB: For two components products, tests are done on each component where appropriate.

(1) For density greater than 2,0 g·cm-3, the relevant tolerance is ± 0,1 g·cm-3;

for density lower than 1,0 g·cm-3, the relevant tolerance is ± 0,03 g·cm-3.

“x” - Value provided by paint manufacturer, and agreed upon by contractor and manufacturer

CHAPTER 9 TEST REPORT

The test report shall contain at least the following information:

a. test laboratory (name and address)

b. date of tests

c. description of the underwater hull paint system (see § 6.1)

d. environment where the underwater hull paint system is applicable and qualification tests carried out

e. description of the preparation and conditioning of the test panels (see § 7.1)

f. assessment before performance tests

g. assessment after performance tests

h. any deviation from the test methods specified.

ANNEX A - PRODUCT TECHNICAL INFORMATION

A.1 UHPS TECHNICAL DATA SHEET
A.2 REQUIRED PRODUCT INFORMATION (ISO 20340)
A.3 USE REFERENCES
A.4 SYSTEM MODIFICATIONS

A.1. UHPS TECHNICAL DATA SHEET

		Name of paint system :															N° :					
		DESCRIPTION : Paint system for the protection of ships exterior hulls															EDITION :					
		SURFACE PREPARATION : Steel plating (ISO 8501-3), Cleanliness (ISO 8501-1), Level of pollution [dust, humidity , oil, grease, soluble salts] (ISO 8502), Roughness (ISO 8503) Paints need to be applied onto properly prepared surfaces, which are dry and free of contaminants in accordance with ISO 8502																			
Paint system		Colour	Number of coats	Dry thickness : per coat (µm)			Weight of dry film ① (g·m-2·coat-1)	Wet thickness: per coat (µm)	Application Density (g·m-2·coat-1)	Solid content by volume (%)	Spreading rate (m2·L-1)	Provisioning prediction ② (L·m-2 per coat)	Application modes ③										
Paint Reference	Data sheet reference			Nom;	mini	maxi							B	R	P	T	E					
Paint characteristics		Contractual Dry thickness (µm)						Total weight of dry paint system (g·m-2)				Duration before service life:										
Paint Reference		Name of products						Drying time (dry to touch) 20 °C	Overcoat time at 20 °C		Pot life④	Minimum temperature for application		Flash Point (°C)		Thinner						
									minimum	maximum												
REMARKS																						
① - For nominal Thickness, ② - Average loss : ≈ 30 % (indicative value), ③- B : Brush, R: Roller, P: Gun, T: Trowel, E: Electrostatic gun, ④ - Usable time after mixing																						

A.2. REQUIRED PRODUCT INFORMATION (ISO 20340)

At least the following information, in addition to the Material Safety Data Sheet, shall be provided with each product submitted to the qualification procedure:

Date of Issue
Name of the Product
Name of Manufacturer
Generic Name for the Paint
Generic Name for the Curing Agent(1)
Generic Name for Each Additional Component
Colour of Paint
Mixing Ratio(1)
Mixing Instructions (including the induction time) (1)
Shelf Life Under the Recommended Storage Conditions
Non-Volatile Matter by Volume of Mixed Product
Density of Mixed Product
Pot Life
Flash Point of Each Separate Component
Drying Time
Time to Full Curing
Recommended Thinner(2)
Flash Point of the Recommended Thinner(2)
Maximum Quantity of Thinner Allowed for Application(2)
Surface Preparation and Profile Requirements
Recommended Application Method
Nominal Dry Film Thickness and Nominal Wet Film Thickness
Minimum and maximum over-coating time
Recommended Minimum and Maximum Drying Time in Accordance with Environmental Conditions
Solvent for Cleaning
Application Conditions (temperature, RH)
VOC
Reference to the Material Safety Data Sheet
Theoretical Spreading Rate
Biocide Identification
Biocide Registration (and/or Paint Registration where necessary)
Recommended repair or maintenance coating

Notes:
(1) Where relevant (e.g., multi-component paint systems)
(2) Where thinners are permitted by prevailing regulations

A.3. USE REFERENCES

Date of issue	
Name of manufacturer	
Name of paint system	
Description of paint system (name and number of coat, thickness)	
Name of the structure where the paint system is applied	
Date of paint system application	
Environmental conditions of the ship/vessel	
Paints and coat thickness on ship/vessel	
Locations	
General behaviour of paint system (date)	
Failures (rusting, blistering, cracking, chalking…)	
Adhesive properties of paint system on structure	
Others tests or checking done on the structure coated by paint system)	
Details of maintenance work (nature, paint quantity, area, date,...)	

A.4. SYSTEM MODIFICATIONS

Designation			Edition
Manufacturer			
Formula index		Date of formulation	
New index of formulation		New Date of formulation	
Nature of the deviation			
Reasons			
Analysis of consequences			
Qualification tests done			
Use References for the new product			
Conclusions			

ANNEX B - SPECIFIC TEST METHODS

B.1 Evaluating Re-Coatability and Repairability
B.2 Suitability for Application
B.3 Accelerated Storage Stability
B.4 Method for Conducting Sample Panel Testing
B.5 Method for Conducting Ship Hull Patch Testing
B.6 Method for Conducting Full Hull Ship Testing

B.1. EVALUATING RE-COATABILITY AND REPAIRABILITY

B.1.1. - SCOPE

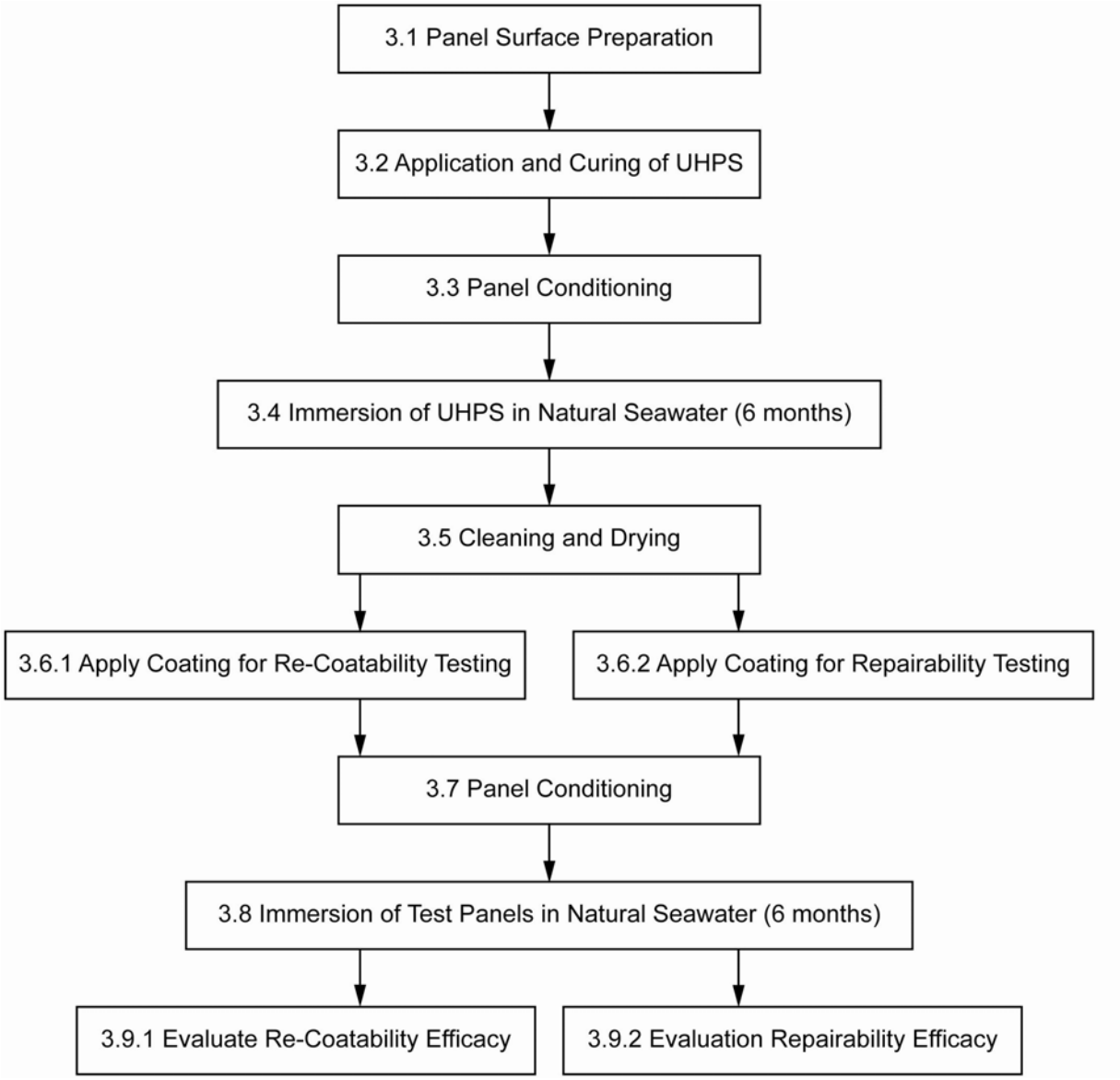
The aim of this method is to describe the different tests to evaluate the re-coatability for the topcoat and the repairability of the paint system (submitted for qualification process) by re-coating with a standard maintenance paint system.

B.1.2. - FIELD OF APPLICATION

This method covers antifouling paint systems.

B.1.3. - TEST PROCEDURE

Flow Diagram of Test Steps



Operating details of each step are given in the following paragraphs

B.1.3.1. Panels and Surface Preparation

Theses panels have are steel of grade E 24 or equivalent, and of a size which will permit testing which will yield results which are accurate, reproducible, and repeatable (e.g. : 250 x 150 x 4 mm)

The surface preparation of panels is in accordance with the technical data sheet of paint system submitted to qualification. If levels of surface preparation are not specified the following levels are used:
- Visual cleanliness: A Sa 2½ (ISO 8501-1)
- Roughness: MG (ISO 8503)
- Surface pollution (ISO 8502):

Soluble salts < 5µg·cm-2 (chloride equivalent),
Dust < 2,
Oil, grease 0.

B.1.3.2. Paint Application

Paint or paint system, submitted for qualification, is applied in accordance with technical data sheet requirements. Nominal dry film thickness (NDFT) of paints and application conditions are those given in technical data sheet.

B.1.3.3. Panel Conditioning Before Exposure to Marine Biofouling

After paint application or paint system application, panels are allowed to cure in accordance with technical data sheet requirements, under controlled conditions: temperature 23 °C ± 2 °C and relative humidity of 50 ± 5 %.

B.1.3.4. Paint System Aging by Exposure to Marine Biofouling

Panels coated by paint system submitted for the qualification process are aged by exposure to natural marine biofouling in accordance with § 7.2, for a length of time agreed upon by the manufacturer (or representative of same) and the qualifying activity, but for not less than six (6) months.

B.1.3.5. Cleaning and Drying of Panel Paint Systems

After biofouling immersion exposure testing for specified time, remove from seawater and before drying occurs, rinse with fresh water, for a maximum of 2 minutes at 5 MPa (nominal), followed by drying for 24 hours at a temperature of 23 °C ± 2 °C and relative humidity of 50 ± 5 %.

B.1.3.6. Maintenance Topcoat or Maintenance Paint System Application

B.1.3.6.1. Apply Coating for Re-coatability Testing

Maintenance topcoat shall be specified (antifouling topcoat only) and applied as specified in vendor information for the original paint system, or by mutual agreement between vendor and qualifying activity.

At this stage, any problems identified during application and drying are noted (softening, lifting, raising, peeling, swelling, discolouring, bleeding, etc.).

B.1.3.6.2. Apply Coating for Repairability Testing

The exposed antifouling shall be completely removed by sanding prior to repairability testing. Repair paints shall be specified (anticorrosive paint and antifouling topcoat) and applied as specified in vendor information for the original paint system, or by mutual agreement between vendor and qualifying activity.

At this stage, any problems identified during application and drying are noted (softening, lifting, raising, peeling, swelling, discolouring, bleeding, etc.).

B.1.3.7. Panel Conditioning Before Test

After application of topcoat or paint system on aged primer or aged paint system, panels are conditioned over seven days – or for an amount of time consistent with vendor instructions – under controlled conditions: temperature 23 ± 2 °C and relative humidity 50 ± 5 %.

B.1.3.8. Paint System Aging by Exposure to Marine Biofouling

Re-coated panels are aged by exposure to natural marine biofouling in accordance with § 7.2, for a length of time agreed upon by the manufacturer (or representative of same) and the qualifying activity, but for not less than six (6) months.

B.1.3.9. Behaviour Evaluation and Acceptance Criteria

B.1.3.9.1. Visual Examination

Failures observed by visual examination are noted during and after tests, in accordance with ISO 4628.

B.1.3.9.2. Pull-Off Test (ISO 4624)

Pull off test is carried out on 3 areas of panels and compared to reference panel.

B.1.3.9.3. Acceptance criteria

Acceptance criteria are provided below.

ACCEPTANCE CRITERIA	
Visual examination (1)	No failure Blistering, bleeding, blushing, peeling
Pull-Off Test	No adhesive failure between old system and new coat > 1.5 MPa adhesion ≥ 50% of original value

(1) During and after application, drying, conditioning phases

B.2. SUITABILITY FOR APPLICATION

Each paint of paint system submitted to qualification shall be applied with brush, roller, or spray, without runs and sags to vertical and smooth sheet metal with minimum area of 1 m², with a mean wet film thickness (WFT) appropriate for obtaining a nominal dry film thickness (NDFT) consistent with 1.5 times product instructions; test temperature shall be 23±2°C. Paints are applied in accordance with technical data sheet conditions of paint manufacturer.

B.3. ACCELERATED STORAGE STABILITY

An accelerated storage stability test shall be conducted on all components of the UHPS, as follows:

A previously unopened original container of paint, after exposure to a temperature of 60°C for 30 days, shall be capable of being readily dispersed with a mechanical mixer within 5 minutes to a smooth uniform condition.

Paint shall be free of grit, seed, tough or gummy sediment, skin, hard pigment settling and persistent foam.

Paint aged by this method shall have characteristics no different from any other paint of the same type that has been determined to be acceptable for application (i.e., the same values for nominal wet film thickness, drying time, colour, etc.).

B.4. METHOD FOR CONDUCTING SAMPLE PANEL TESTING

B.4.1. SCOPE

The aim of this method is to describe the manner in which test panel samples are coated with UHPSs, which are then evaluated for resistance to marine biofouling.

B.4.2. FIELD OF APPLICATION

This method covers antifouling paint systems containing antifouling topcoat paints of type R, D, or I, as described in § 5.6.

B.4.3. TEST PROCEDURE

Substrate panels are identified and prepared as described in § 5.5 and § 7.1. For full immersion testing (antifouling topcoat paints of types R or D, in accordance with § 5.6), a minimum of four panels shall be prepared as required in § 6.2.2, so that three can be immersed in a vertical orientation, and one in a horizontal orientation. For the panel to be exposed while in a horizontal position, only one side is required to be coated with the full antifouling paint system; the other side shall be protected from exposure to fouling for the duration of the test, so it only requires paint with a suitable anticorrosive paint system. For panels to be oriented in a vertical position, both sides are coated with the complete antifouling paint system.

For waterline immersion testing (antifouling topcoat paints of types R or D, in accordance with § 5.6), at least three panels shall be prepared, having the same width as the full immersion sample panels, but of sufficient length to permit exposure of a minimum length of 30 mm of coated surface to air, with the remainder of the panel kept in full immersion in a vertical orientation. Panels shall have a minimum length of 450 mm and a minimum width of 150 mm.

For antifouling topcoat paints of type I, as described in § 5.6, panel dimensions are chosen which are compatible with the flow channel to be used in the evaluation, as described in § 7.2, but of a minimum size to permit adequate testing accuracy, reproducibility and repeatability. [Panel substrate dimensions of 300 mm length, 150 mm width, and 3 mm thickness have been found to be adequate; flow channel dimensions and testing requirements of § 7.2 will determine the actual required panel size, however.] Holes shall not be drilled anywhere in the substrate, unless agreed to by all parties, in order to avoid the presence of potential failure (peeling, disbondment) sites during flow channel exposure.

The UHPS is applied and cured in accordance with manufacturer's issued written instructions, as well as § 6.2.2 and § 7.1, or in a manner mutually agreed to in writing by all parties concerned. Nominal dry film thickness (NDFT) shall be recorded before immersion commences.

Panels are immersed in one of the natural seawater sites identified in this annex, where heavy marine biofouling is known to take place. Vertical full immersion panels (paint types R or D) are immersed with their uppermost edges at least 0.3 m below the water surface, and at most 3 m below the water surface. Horizontal immersion panels (paint types R, D, or I) are immersed at a nominal depth of 1m, with the test surface facing downward, and the opposite (back) surface affixed to a supporting structure which protects it from exposure to fouling organisms.

To avoid the effects of tidal variations, panels shall preferably be suspended from a supporting flotation structure such as a raft or buoy, in order to maintain a constant depth; this is an absolute requirement for waterline immersion samples. By mutual agreement of all parties concerned, full immersion panels can be rigidly supported at a depth such that no air exposure ever takes place on any part of the coated surface. Actual depth of immersion shall be recorded and reported with the test results.

For antifouling topcoats of type R or D, evaluations take place on a monthly basis, in accordance with ASTM D 3623. Performance testing is continued in accordance with § 7.2 until the end of the testing period.

For antifouling topcoats of type I, panels are evaluated in accordance with § 7.2.

Natural marine biofouling sites used for panel immersion exposure by member nations.

Nation	Location of the site [Immersion in natural seawater (Im-2) exhibiting heavy biofouling]	Exposure Duration	Contact
USA	Biscayne Bay, Miami FL Pearl Harbor, HI Daytona Beach, FL Singapore	12/24 months 24 months 24 months 12 months	NAVSEA 05P23
AUS	Melbourne, Australia Cairns, Australia	As required	DSTO Melbourne
FRA	Toulon, France	24 months	DGA/CTSN
CA	TBD		

B.5. METHOD FOR CONDUCTING SHIP HULL PATCH TESTING

B.5.1. SCOPE

The aim of this method is to describe the manner of application, testing, and evaluation of UHPS patches applied to the hulls of commercial or government (Navy) vessels.

B.5.2. FIELD OF APPLICATION

This method covers antifouling paint systems containing antifouling topcoat paints of type R, D, or I, as described in § 5.6.

B.5.3. TEST PROCEDURE

The ships which shall serve as platforms for this testing shall operate in high biofouling tropical or subtropical waters. The antifouling paint system shall be applied in accordance with the manufacturer's written instructions (product data sheet), unless an alternative procedure is agreed to by all interested parties; one alternative would be the application of only the antifouling topcoats, perhaps over an already approved antifouling paint to which the test paint is known to adhere and with which it is compatible.

For underwater hull areas, test patches of 6m width (minimum) shall be applied amidships, running from the keel to the heavy load line. For boottop (waterline) areas, test patches of the same size shall be applied to run from the heavy load line to the light load line. The test patches shall include the following:

A 2 m wide (minimum) section of the complete antifouling paint system being qualified.
A 2 m wide (minimum) section of the system undergoing testing with a previously approved anticorrosive paint.
A 2 m wide (minimum) section of an antifouling paint system already qualified in accordance with this AEP, and of the same type and service life as the antifouling paint system undergoing qualification evaluation.

Commercial vessel patch tests shall take place on non-navy ships, which at the discretion of the navy activity responsible for this testing, may include other non-navy government ships. Application and inspections of patch test on navy vessels shall be at a naval shipyard or under navy contract at a commercial shipyard. Application and inspection shall be certified and verified by an independent third party mutually agreed on by the authorizing navy activity and paint manufacturer.

Ship inspections shall be conducted in accordance with ASTM F 1130 or similar, and ratings of waterborne vessels shall be in accordance with standard industry practices. Checking, cracking, and blistering shall be reported in accordance with ISO 4628. Biofouling or physical failure due to verifiable physical damage that has either removed part of the antifouling paint system, i.e., the antifouling topcoat down to the anticorrosive coat; or that has removed the entire system down to the bare structural surface (e.g., steel), shall not be counted as either physical or fouling failure of the paint, for that portion of the test surface which it covers. As such, it may be subtracted from the percentage area fouled or with physical damage to the anticorrosive layer, as the circumstance warrants. The report shall include observations of erosion/fouling of high wear or high fouling potential, such as projections, brackets, gratings and seachests.

B.6. METHOD FOR CONDUCTING FULL HULL SHIP TESTING

B.6.1. SCOPE

The aim of this method is to describe the manner of application, testing, and evaluation of antifouling paint systems applied over the entire hulls of commercial or government (Navy) vessels.

B.6.2. FIELD OF APPLICATION

This method covers antifouling paint systems containing antifouling topcoat paints of type R, D, or I, as described in § 5.6.

B.6.3. TEST PROCEDURE

The ships which shall serve as platforms for this testing shall operate in high biofouling tropical or subtropical waters. The antifouling paint system shall be applied in accordance with the manufacturer’s written instructions (product data sheet), unless an alternative procedure is agreed to by all interested parties; one alternative would be the application of only the antifouling topcoats, perhaps over an already approved antifouling paint to which the test paint is known to adhere and with which it is compatible.

Full ship applications shall consist of a full hull application of the manufacturer’s total commercial system, except that the following shall be included:

Antifouling topcoats (and tie-coats, if any) being qualified with a previously approved anticorrosive paint shall be applied as a belly band – either boottop-to-boottop via the keel, or waterline-to-waterline via the keel, as appropriate – with a minimum width of 6m.

Unless waived by the qualifying activity, there shall be a controlled paint system applied which has been chosen from among those already qualified by this AEP, or otherwise approved by the qualifying activity. This control paint shall be applied as a belly band, in the manner described in the previous paragraph, and also with a minimum width of 6m.

When testing takes place on non-navy vessels, whether commercial or of other government agencies, applications and inspections must be certified and verified by an independent third party mutually agreed upon by the qualifying navy activity and the paint manufacturer, or a representative of the manufacturer. Vessel operations shall be certified and verifiable with travel, port time and lay-up times documented.

Application and inspections of navy vessels shall be at a naval shipyard or under navy contract at a commercial shipyard.