Guideline No.A-01 (202204)

A-01

COATING

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Foreword

China Classification Society (hereinafter refferred to as CCS) Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

Historical version and release date: A01(201510) October 20, 2015

Main change:

Perfect the application, technical requirement, type test and Annex 4.

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COATING

1 Application

1.1 The Guideline applies to the works approval and inspection on marine coatings.

1.2 Marine coatings are classified as follows as per the position applied on the ship and the application: the shop primer for shop building, anticorrosive paint for ship hull, anti-fouling paint for ship hull, anodic shielding coating, anticorrosive paint for ship, boottopping paint for ship, topside paint, deck paint, oil tank paint for ship, internal compartment finish coating, drinking water tank coating of shipbuilding, ballast tanks paint for ship, engine room bottom coating, oil tank paint for ship, and cargo oil tanks paint of crude oil tankers. For marine coating classification and application, see Table 1.2:

Marine coating classification and application **Table 1.2**

Classification and name		Application
Shop primer for shop building		Applicable to the application on marine steel plates, steel sections and molding parts with shot blasting (peening) surface treatment meeting grade requirement for temporary protection on rolled steel.
Coating used under the ship waterline	Anticorrosive paint for ship hull, Tie paint for ship hull	Applicable to the external surface under the ship's designed waterline, including the hull waterline.
	Anti-fouling paint for ship hull	Applicable to the external surface under the ship's designed waterline, including the hull waterline to prevent fouler from attaching to the ship.
	Anodic shielding coating	Applicable to the auxiliary anode of the additional current cathodic protection system of the ship.
Ship used above coating	Anticorrosive paint for ship	Applicable to the part above the ship's designed waterline and the internal structure (except for the liquid tank).
	Boottopping paint for ship	Applicable to the external surface of the hull between the full-load waterline and light-load waterline of the ship rather than the waterline paint with anti-fouling effect.
	Topside paint	Applicable to the external face of the structure above the full-load waterline of the ship, or the mast and hoisting machinery.
	Deck paint	Applicable to the iron and steel surface (for example, the ship deck) for protection.
	Oil tank paint for ship	Applicable to the dry cargo hold of the ship and steel structure in the space for protection, or partially to the cargo hold for carrying bulk grain food.
	Internal compartment finish coating	Applicable to the exposed internal surface of the cabin, superstructure and/or deck house.
Ship liquid space coating	Drinking water tank coating of shipbuilding	Applicable to the internal surface of the marine drinking water tank.
	Ballast tanks paint for ship	Applicable to the internal surfaces in the special seawater ballast tanks of all ships and those at both sides of the bulk cargo ship.
	Engine room bottom coating	Applicable to the marine main engine, auxiliary engine and pump room bottom.
	Oil tank paint for ship	Applicable to the internal surface of the oil tank used for carrying petroleum hydrocarbons except for such special oils as the aviation gasoline and aviation kerosene for protection.
	Cargo oil tanks paint of crude oil tankers	Applicable to the internal surface of the cargo oil tank of the crude oil tanker for protection.

2 Normative references

2.1 CCS Rules for Classification of Sea-Going Steel Ships, Guidelines for Survey of Structure Anti Corrosion for Ships, and Rules for Material and Welding;

2.2 IMO Convention on the Safety of Life at Sea (1974) and its Amendment; Parts 2 and 5 of the International Code for Application of Fire Test Procedures (IMO 2010 FTP CODE).

2.3 International Convention on Control of Harmful Anti-fouling Systems on Ships of IMO (2001) and its Amendments (AFS)

2.4 Performance Standard of Protective Coatings for Dedicated Seawater Ballast Tank of All Ships and both Sides of Bulk Cargo Ship (IMO MSC.215(82)) (PSPC), Performance Standard of Protective Coatings for Void Space of Bulk Cargo Ship and Oil Tanker (MSC.244(83), Performance Standard of Protective Coatings for Cargo Oil Tank of Crude Oil Tanker (MSC.288 (87).

2.5 ISO 13073-1 Ships and marine technology - Risk assessment on anti-fouling systems on ships - Part 1: Marine environmental risk assessment method of biocidally active substances used for anti-fouling systems on ships.

2.6 International standards and those accepted by CCS.

In case of any change to the above-mentioned standards, CCS will follow the latest valid provisions.

3 Terms and definitions

For the purpose of the Guideline, the definitions in the conventions and the following apply:

3.1 Coating: The collective name of a type of liquid or solid material (also called the "Paint") that is applied on the object surface to form solid film with protective, decorative or special performance (such as insulation, corrosion prevention and marking).

3.2 Shop primer for shop building: The primer applied on the steel plate surface before being processed generally in the automatic workshop.

3.3 Anti-fouling composition (anti-fouling active substances): The chemical compound in the anti-fouling paint for ship hull that can prevent the fouler generally or specifically (for example, lethality, growth inhibition or repellence on fouler), which applies to substances used in the anti-fouling system to prevent aufwuch from attaching. The Guideline provides no strict classification on such terms as the anti-fouling composition, anti-fouling active substances, biocide, and biocidal agent.

3.4 Environmental risk assessment on anti-fouling active substances in the anti-fouling paint for ship hull: The quantitative or qualitative proposal on the potential impact of the anti-fouling active substance in the anti-fouling paint for ship hull on the environment by inspecting the exposure caused by chemical emission or release as well as the impact of such exposure on the structure and function of the marine environment ecosystem.

4 Drawings and documents

The applicant should submit the works approval application and the following documents to CCS for review:

4.1 Particulars of manufacturer: Name, address, production history, production capacity, technical and inspection personnel, main products, affiliation, product brand, main production equipment

and test equipment, and brief production process.

4.2 Details of products applied for approval: The name, type, classification and application (listed in detail in case of multiple applications), main film-forming materials, and involved supporting coating system solutions of the product to be approved. CCS accepts the complete supporting coating system (except for the shop primer for shop building).

4.3 Technical conditions for inspection and delivery / enterprise standard: The technical requirement of product should meet the requirements of the convention, regulations and standards accepted by CCS. The test method of other standard, if adopted for product performance determination, should be approved by CCS.

4.4 Product instructions: Include the detailed technical description and data related to coating and application, so as to provide users with guidance on coating selection, construction and maintenance. It should involve at least the product name, identification marking and/or number, material, component, composition, and color of the coating system, application interval, min. and max. dry film thicknesses, application method, tool and/or machinery, surface condition (derusting grade, cleaness and roughness) and environmental restrictions (temperature and humidity) before application.

4.5 Test program: Specify the test item, test method and relevant technical index, technical standard, test site, handling principle on test disqualification.

4.6 Others: Quality management document, business registration certificate, qualification proof and /or safe production license, quality management system certificate, MSDS (if necessary), list of qualified suppliers of main raw materials, product quality certificate sample, and no-asbestos declaration.

4.7 For approval application of anti-fouling paint for ship hull, declaration of no organotin or substances forbidden by such conventions as the DDT, as well as the active ingredient name and the register number of the Chemical Abstracts Service (CAS register number) of the anti-fouling composition (anti-fouling active substances) in the anti-fouling paint.

5 Technical requirements

5.1 Shop primer for shop building

5.1.1 The composition of the shop primer for shop building should not affect the weld seam quality or welding operation in the future, and should adapt to the paint or coating related to the structure corrosion protection system used in the future. The shop primer for shop building should widely match with the subsequent paint coating, with sound recoatability on the old film of the shop primer exposed for a long time. There are two types of shop primers, namely, one with zinc powder (Type I) and the other without zinc powder (Type II).

5.1.2 The test items and result requirement of the shop primer for shop building are as follows:

(1) Drying time: The surface drying time should not exceed 5 min according to method B of the surface drying time measurement method of GB/T1728.

(2) Adhesive force: It should be measured as per GB/T1720 and not lower than grade 2.

(3) Paint film thickness: It should be measured as per GB/T13452.2, and the thickness of the

paint film applied onto the steel plate in the assembly line should be measured as per Annex A.1 of GB/T6747. The thickness of the shop primer with or without zinc powder is 15 μm-20 μm or 20 μm-25 μm respectively.

(4) The metal zinc content in the nonvolatile content (the shop primer with zinc powder): It should meet the technical requirement of product.

(5) Weather resistance: It should be measured as per GB/T9276, and the result evaluation conducted as per GB/T1766. For weather resistance requirement, see Table 5.1.2:

List of shop primer weather resistance requirements Table 5.1.2

Shop primer	Grade	Test condition	Acceptance requirement
Shop primer with zinc powder	I-12	Insolated in maritime climate environment for 12 months	Rusting of not more than grade 1
	I-6	Insolated in maritime climate environment for 6 months	
	I-3	Insolated in maritime climate environment for 3 months	
Shop primer without zinc powder	II	Insolated in maritime climate environment for 3 months	Rusting of not more than grade 1

(6) Welding and cutting: The test program can be formulated with reference to the "Welding and Cutting Test on the Shop Primer for Shop Building" (see Appendix 1 of the Guideline). CCS will supervise the test panel preparation, confirm the welding quality of the welding unit, and witness the mechanical properties test. The area of the paint film damaged (heat-affected area) during welding, cutting and hot work calibration should be small, and the cutting speed reduction should not exceed 15%.

5.2 Anticorrosive paint for ship hull, Tie paint for ship hull

5.2.1 The anticorrosive paint for ship hull system can be multiple layers of single anti-rust paint, or consist of anti-rust primer and anti-rust finishing coat. It can be classified into the bi-component paint (Type-I) and single-component paint of solvent evaporation type (Type II) according to the film formation mechanism of the anti-rust paint. The tie paint for ship hull is usually single paint。

5.2.2 Technical feature of the anticorrosive paint for ship hull and tie paint for ship hull:

(1) Volume fraction of the nonvolatile content: It should be tested as per GB/T9272 and meet the technical requirement of product.

(2) Volatile organic compound (VOC): It should be tested as per GB/T 23985 or GB/T 23986 and meet the technical requirement of product.

(3) Density: It should be tested as per GB/T6750 and meet the technical requirement of product.

(4) Color: It should be tested as per GB/T9761 and meet the technical requirement of product.

(5) Viscosity: It should be tested as per GB/T1723, GB/T9269, GB/T9751.1, or the test method specified for the product, and meet the technical requirement of product.

(6) Flash point: It should be tested as per GB/T5208 and meet the technical requirement of product.

(7) Drying time: It should be tested as per GB/T 1728 and meet the technical requirement of product for surface drying; the hard drying time should not exceed 24 h.

5.2.3 Coating property of the anticorrosive paint for ship hull system:

(1) Adhesive force (except for type-II asphalt bitumen): The adhesive force of the anticorrosive paint for ship hull system and the base material should be tested as per GB/T5210, which should exceed 3.0 MPa.

(2) Immersion resistance (except for type-II asphalt bitumen): The sample should be prepared as per GB/T10834, and result evaluated as per GB/T 1766. Blisters of grade 1 (S2) or less or other surface defects with slow or slight growth in the first 10 cycles (70 d) during the immersion test can be negligible. After 20 cycles (140 d) of immersion, the rusting of the paint film should not exceed grade 1 (S2), blistering not exceed grade 2 (S3), and appearance color change not exceed grade 1. After being immersed, the adhesive force of the anti-rust paint system on the repainting surface should not be less than 50% of that of the original one.

(3) Blistering resistance (applicable to bi-component anti-rust paint): The plating and saline solution should be prepared as per GB/T10834, and the test temperature in the first cycle should be 88℃±3℃. Such condition should be kept of 14 d. Take out the test panel, clean and dry it, and then polish one surface of each plate with the emery cloth (100＃) manually; clean and dry the polished surface, apply one layer of finishing coat, and dry it for 7 d. After that, conduct the second cycle test with the test panel immersed into the saline water of 38℃ ±2℃ or natural seawater for 14 d. Take out the test panel, check it and record the blistering status (neglect the area located within 6 mm of the edge inward). After the hot saline water immersion test, the anti-rust paint system should be free of blister.

(4) Cathodic disbonding resistance: It should be tested as per GB/T7790. The anti-rust paint system should fit the cathodic protection method of the ship, and the zinc anode should be adopted with test time of 182 d. After test, the average distance between the disbonded coating and the outer edge of the artificial leakage hole should not exceed 8 mm, namely, the diameter of the equivalent calculation circle of the disbonded coating around the whole artificial leakage hole should be within 19 mm. If the anti-rust paint system is subject to the cathodic protection resistance test together with the supporting anti-fouling paint, no separate cathodic disbonding resistance test is required for the anti-rust paint.

5.3 Anti-fouling paint for ship hull

5.3.1 The anti-fouling paint for ship hull should be able to prevent the marine organism from attaching but have no excessive adverse impact on non-target organism or human being. The anti-fouling paint can be classified into three types as per the anti-fouling mechanism, namely, Type I (anti-fouling paint with anti-fouling composition of self-polishing or abrasion type), Type II (anti-fouling paint with anti-fouling composition of non self-polishing or non abrasion type), and Type III (anti-fouling paint without anti-fouling composition of non self-polishing or non abrasion type). It can be classified into three types as per the chemical composition of the anti-fouling composition, namely, Type A (copper and copper compound), Type B (non copper and copper compound), and Type C (others). It can be further classified into three types as per the application validity, namely, the short term, medium term, and long term.

5.3.2 Technical requirement on the anti-fouling composition (anti-fouling active substances) of the anti-fouling paint for ship hull

(1) Tributyltin (TBT), dichlorodiphenyl trichloroethane (DDT), cybutryne (CAS No. 28159-98-0, trade name : Irgarol 1051) or chemical substances forbidden by national departments concerned cannot be used as the anti-fouling composition of the anti-fouling paint for ship hull. The test items and result requirements are as follows:

① Tributyltin (TBT): It should be tested as per the "Determination Method on the Total Tin Content and Organotin Content in the Anti-Fouling Paint for Ship Hull" (see Appendix 2 of the Guideline). If the total tin content is less than 2500 mg/kg dry paint sample (the allowable deviation is ±500 mg/kg dry paint sample), it can be determined that no organotin is added as the anti-fouling composition.

② Dichlorodiphenyl trichloroethane (DDT): It should be tested as per GB/T 25011. If the DDT detected is ≤1000 mg/kg, it can be determined that no DDT is added as the anti-fouling composition.

③ Cybutryne: It should be as per the requirements of MEPC.331(76) Amendments to AFS Convention, the anti-fouling composition (anti-fouling active substances) of cybutryne shall not be used.

(2) The anti-fouling active substances in the anti-fouling paint for ship hull should be subject to environmental risk assessment to guarantee that it will not cause impact with high risk on the environment and organism.

The anti-fouling active substances in all anti-fouling paints applied for approval should be subject to evaluation as per supplementary provisions 2 and 3 of AFS convention as well as the method of Marine Environment Risk Assessment Methods on Anti-fouling Active Substances in the Marine Anti-fouling Systems (ISO 13073-1). For guidance on environmental risk assessment, see Appendix 3 "Environmental Risk Assessment Method of Anti-Fouling Active Substances in Anti-Fouling Paints" of the Guideline.

Appendix 4 "List of common anti-fouling active substances in the anti-fouling paint for ship hull" of the Guideline provides the common anti-fouling active substances in the anti-fouling paint for ship hull, and the environmental risk assessment is not required temporarily if anti-fouling paints with such substances as the anti-fouling composition are applied for approval at present. However, further evaluation may be required with the technical progress and other discovery in the future. Such list does not mean that those anti-fouling active substances are recommended to be used as the anti-fouling composition of the anti-fouling paint by CCS, and such anti-fouling active substances in Table 4.2 of the list should be used with caution.

(3) The application amount of anti-fouling composition used in the anti-fouling paint should not exceed the suggested value based on the environmental risk assessment, and the determination and requirement of the anti-fouling composition content are as follows:

① Copper (copper and copper compound) anti-fouling composition: The total copper content should be measured as per Annex E "Method of determining total copper content in the ship anti-fouling paints - flame atomic absorption spectrometry" of GB/T6822, and

the result should meet the technical requirement of product.

② Other anti-fouling compositions: Meet the technical requirement of product.

5.3.3 Technical feature requirement of the anti-fouling paint for ship hull

(1) Nonvolatile content: It should be tested as per GB/T9272 and meet the technical requirement of product.

(2) Volatile organic compound (VOC): It should be tested as per GB/T 23985 or GB/T 23986 and meet the technical requirement of product.

(3) Density: It should be tested as per GB/T6750 and meet the technical requirement of product.

(4) Color: It should be tested as per GB/T9761 and meet the technical requirement of product.

(5) Viscosity: It should be tested as per GB/T1723, GB/T9269, GB/T9751.1, or the test method specified for the product, and meet the technical requirement of product.

(6) Flash point: It should be tested as per GB/T5208 and meet the technical requirement of product.

(7) Drying time: It should be tested as per GB/T 1728 and meet the technical requirement of product for surface drying; the hard drying time should not exceed 24 h.

5.3.4 Coating property requirement of the anti-fouling paint system for ship hull

(1) Anti-fouling property

① Shallow sea immersion: It should be tested as per the shallow sea immersion test method for anti-fouling paint test panel of GB/T5370, and the result should meet the shallow sea immersion requirement (see Table 5.3.4.1).

List of requirements on shallow sea immersion of the anti-fouling paint for ship hull Table 5.3.4.1

Anti-fouling paint system for ship hull	Lifetime	Test cycle	Acceptance requirement
Short-term anti-fouling paint	Less than 3 years	Peak growth season for one marine organism	Check and evaluate it at least once half a year. The anti-fouling coating should be free of peeling or scaling.
Medium-term anti-fouling paint	Not less than 3 years but less than 5 years	Peak growth season for two marine organisms	
Long-term anti-fouling paint	Not less than 5 years	Peak growth season for three marine organisms	

② Polishability (abradability) of the anti-fouling coating: It should be tested as per GB/T31411. The polishing or abrasion rate of the anti-fouling coating of the Type-I anti-fouling paint should comply with the identified feature and performance, and the result should meet the technical requirement of product (such requirement does not apply to the Type-II and Type-III anti-fouling paint).

③ Dynamic simulation test: It should be tested as per the method of GB/T 7789, and the test procedures for Type-I and Type-II anti-fouling paints should meet the requirement of Section 4.3 of GB/T 7789. For Type-III anti-fouling paint, the test procedure is as follows: put the test sample first into the test buoyant raft for shallow sea immersion test on the anti-fouling paint for 10 days - 2 months (which should be determined according to the technical requirement of product, and the max. applicable static harbor immersion time should be noted in the test result), check the cover area of scale fouling organisms (barnacle, shell sea moss, and hydroides) on the test sample surface and other fouler, and then make record and take photos; after that, move the test panel onto the dynamic test device, adjust the linear velocity on the test sample surface to (18±2) knots (Kn), let the sample run contentiously for a distance equivalent to a navigation of (4000±50) n miles, check the cover area of scale fouling organisms (barnacle, shell sea moss, and hydroides) on the test sample surface, and then make record and take photos. That is a cycle of the dynamic test. For dynamic simulation test requirement, see Table 5.3.4.2.

List of requirements on dynamic simulation test of the anti-fouling paint for ship hull
Table 5.3.4.2

Anti-fouling paint system for ship hull	**Test cycle**	**Acceptance requirement**
Short-term anti-fouling paint system	There should be 3 test cycles, with the last one conducted during the peak season for marine organism growth.	1) Check and evaluate it once in each test cycle. The anti-rusting coating should be free of peeling or scaling. 2) The property of the anti-fouling paint should be evaluated as per the method of GB/T 5370. After the test, the Type-I and Type-II anti-fouling paints should meet the requirement of GB/T 5370; the cover area of scale fouling organisms (barnacle, shell sea moss, and hydroides) on the test sample surface of the Type-III anti-fouling paint should not exceed 25% (the max. applicable static harbor immersion time should be noted).
Medium-term anti-fouling paint system	There should be 5 test cycles, with the last one conducted during the peak season for marine organism growth.	
Long-term anti-fouling paint system	There should be 8 test cycles, with the last one conducted during the peak season for marine organism growth.	

5.4 Anodic shielding coating

5.4.1 The test items and result requirement of the anodic shielding coating are as follows:

(1) Color appearance: It should be smooth and uniform via visual inspection under nature light.

(2) Density: It should be tested as per GB/T6750 with density of 1.2~1.4 g/mL.

(3) Drying time: It should be tested as per GB/T1728 at 23±2℃, and the surface drying time should not exceed 4 h; the hard drying time should not exceed 24 h.

(4) Adhesive force: It should be tested as per GB/T5210 with adhesive force of not less than 10 MPa.

(5) Impact resistance test: It should be tested as per ASTM D2794 with impact resistance of not less than 0.408 Kg·m.

(6) Salt mist resistance: It should be tested as per GB/T1771 for 1000 h, and the paint film should be free of blistering, falling-off or rusting.

(7) Potential resistance test: It should be tested as per Annex A of GB/T7788 for 30 d with test potential of (-3.5±0.02) V (with respect to the reference electrode of sliver/silver chloride), and the paint film should be free of blistering, falling-off or rusting.

5.5 Anticorrosive paint for ship

5.5.1 The substrates for dry time and flexibility test, salt mist resistance and salt water resistance test as well as the adhesive force test on the anticorrosive paint for ship are tin plate, steel plate and steel plate or metal test column respectively, and the test items and result requirement are as follows:

(1) Solid content: It should be tested as per GB/T1725 and meet the technical requirement of product.

(2) Density: It should be tested as per GB/T6750 and meet the technical requirement of product.

(3) Viscosity: It should be tested as per GB/T1723, GB/T9269, GB/T9751.1, or the test method agreed, and meet the technical requirement of product.

(4) Flash point: It should be tested as per GB/T5208 and meet the technical requirement of product.

(5) Drying time: It should be tested as per GB/T1728 with one layer of coating with paint film thickness of 20 μm-26 μm, and meet the technical requirement of product for surface drying; the hard drying time should not exceed 24 h.

(6) Adhesive force: It should be tested as per GB/T5210 with one layer of coating with paint film thickness of 40 μm -70 μm, and the adhesive force should be not less than 3 MPa and 5 MPa for single-component paint and bi-component paint respectively.

(7) Flexibility: It should be tested as per GB/T1731 with one layer of coating with paint film thickness of 20 μm-26 μm, and the flexibility should not exceed 2 mm.

(8) Salt water resistance test: It should be tested as per GB/T10834 with one or multiple layers (with an interval of 24 h for each layer) of coating with total dry paint film thickness of 100 μm -150 μm at 27±6℃, and the coating should be free of peeling, blistering or rust spot after being immersed for 96 h, but the color can get light a little or dulling.

(9) Salt mist resistance: It should be tested as per GB/T1771 with one or multiple layers (with an interval of 24 h for each layer) of coating with total dry paint film thickness of 100 μm -150 μm for 168 h and 336 h for single-component paint and bi-component paint respectively, and the paint film should be free of blistering falling-off or rusting.

(10) Adaptability to finishing coat: It should be tested as per GB/T1727. Select proper finishing coat. Apply first a layer of marine anti-rusting paint and then a layer of finishing coating after being dried as per the technical requirement of product. Observe the brushing property during application. Allow the finishing coat to dry for 24 h, and then observe the surface of

the paint film. It can be determined to be qualified if there is no shrinkage cavity, crack, needle eye, blister, peeling, lifting or bleeding.

5.6 Boottopping paint for ship

5.6.1 Both the boottopping paint for ship performance and test method refer to those of the supporting system of the waterline paint and marine rust-proofing paint. Unless otherwise specified, the test should be conducted after all the test panels prepared have been maintained in the condition specified in GB/T9278 for 7 d, and the test items and results are as follows (either Artificial weathering aging or weather resistance can be selected):

(1) Paint film appearance: Conduct visual inspection on the test panel under scattering sunlight. It can be determined to be qualified if the coating is uniform and free of sagging, floating, pinhole, crack or peeling.

(2) Drying time: It should be tested as per GB/T1728, and the surface drying time should not exceed 4 h; the hard drying time should not exceed 24 h.

(3) Impact resistance: It should be tested as per GB/T20624.1 with a spherical punch of 20±0.3 mm in diameter. The mass of the heavy punch is 1 kg without depth control ring, and the heavy punch is adjusted to fall from the position with a height of 500 mm. The punching point test is determined to be passed if there is no paint film falling-off or crack in the punched deformation area. Two test panels should be tested with 5 points on each panel. The test item can be determined to be passed if there is no paint film falling-off or crack at 3 points or more of one test panel.

(4) Adhesive force: It should be tested as per GB/T5210 with adhesive force of not be less than 3 MPa.

(5) Salt water resistance: It should be tested as per GB/T10834 with nature seawater or artificial seawater at 27±6℃ for 7 d, and the paint film should be free of blistering, rusting or falling-off.

(6) Oil resistance: It should be tested as per GB/T9274 in the #15W-40 diesel lubrication oil for 48 h, and the paint film should be free of blistering or falling-off.

(7) Salt mist resistance: It should be tested as per GB/T1771 for 400 h and 1000 h for single-component paint and bi-component paint respectively, and the paint film should be free of blistering, falling-off or rusting.

(8) Artificial weathering aging: For ultraviolet aging, it should be tested as per GB/T14522 with irradiance of 0.68 W/m^2 for ultraviolet UVB-313 of 200 h or the agreed time; for xenon arc aging, it should be tested as per GB/T1865 for 300 h or the agreed time. The paint film color change should not exceed grade 4, and efflorescence should not exceed grade 2 (which can be further agreed for epoxy paint), with crack degree of grade 0.

(9) Weather resistance: It should be tested as per GB/T9276, and the result evaluation should be conducted as per GB/T1766. After being insolated in the marine atmosphere for 12 months, the paint film color change should not exceed grade 4, and efflorescence should not exceed grade 2 (which can be further agreed for epoxy paint), with crack degree of grade 0.

(10) Stroke resistance: It should be tested as per Annex A of GB/T9260 for 2 cycles, and the paint film should be free of blistering or falling-off.

5.7 Topside paint

5.7.1 The topside paint should be compatible with the shop primer for shop building and rust-proofing paint. The dry film thickness of primer of the following test panel should be controlled within (50±10)μm, that of the topside paint within (60±10)μm, and total dry film thickness within (100±10)μm. Unless otherwise specified, the test should be conducted after all the test panels prepared have been maintained in the condition specified in GB/T9278 for 7 d, and the test items and results are as follows:

(1) Paint film appearance: Conduct visual inspection on the test panel under scattering sunlight. It can be determined to be qualified if the coating film is uniform and free of sagging, floating, pinhole, crack or peeling.

(2) Fineness: It should be tested as per GB/T1724 with fineness of not more than 40 μm.

(3) Solid content: It should be tested as per GB/T1725 after the bi-component paint is mixed uniformly as per the product ratio, and the mass fraction of the nonvolatile matter should not be less than 50%.

(4) Drying time: It should be tested as per GB/T1728, and the surface drying time should not exceed 4 h; the hard drying time should not exceed 24 h.

(5) Impact resistance: It should be tested as per GB/T20624.1 with a spherical punch of 20±0.3 mm in diameter. The mass of the heavy punch is 1 kg without depth control ring, and the heavy punch is adjusted to fall from the position with a height of 500 mm. The punching point test is determined to be passed if there is no paint film falling-off or crack in the punched deformation area. Two test panels should be tested with 5 points on each panel. The test item can be determined to be passed if there is no paint film falling-off or crack at 3 points or more of one test panel.

(6) Flexibility: It should be tested as per GB/T1731 with flexibility of not more than 1 mm.

(7) Gloss: It should be tested as per GB/T9754 and meet the technical requirement of product.

(8) Adhesive force: It should be tested as per GB/T5210 with adhesive force of not less than 3 MPa.

(9) Salt water resistance: It should be tested as per GB/T10834 with nature seawater or artificial seawater at 27±6℃ for 48 h, and the paint film should be free of blistering, rusting or falling-off.

(10) Salt mist resistance: It should be tested as per GB/T1771 for 400 h and 1000 h for single-component paint and bi-component paint respectively, and the paint film should be free of blistering, falling-off or rusting.

(11) Artificial weathering aging: For ultraviolet aging, it should be tested as per GB/T14522 with irradiance of 0.68 W/m^2 for ultraviolet UVB-313 of 300 h or the agreed time; for xenon arc aging, it should be tested as per GB/T1865 for 500 h or the agreed time. The

paint film color change should not exceed grade 4, and efflorescence should not exceed grade 2 (which can be further agreed for epoxy paint), with crack degree of grade 0.

(12) Weather resistance: It should be tested as per GB/T9276, and the result evaluation should be conducted as per GB/T1766. After being insolated in the marine atmosphere for 12 months, the paint film color change should not exceed grade 4, and efflorescence should not exceed grade 2 (which can be further agreed for epoxy paint), with crack degree of grade 0.

5.8 Deck paint

5.8.1 The deck paint system is classified into the general system and skid resistance system. Both the following coating performance and test method refer to those of the supporting deck paint system. The dry film thickness of primer should be controlled within (50±10)μm, that of the deck paint within (60±10)μm, and total dry film thickness within (100±10)μm. Unless otherwise specified, the test should be conducted after all the test panels prepared have been maintained in the condition specified in GB/T9278 for 7 d, and the test items and results are as follows:

(1) Paint film appearance: Conduct visual inspection on the test panel under scattering sunlight. It can be determined to be qualified if the coating film is uniform and free of sagging, floating, pinhole, crack or peeling.

(2) Solid content: It should be tested as per GB/T1725 after the bi-component paint is mixed uniformly as per the product ratio, and the mass fraction of the nonvolatile matter should not be less than 50%.

(3) Drying time: It should be tested as per GB/T1728, and the surface drying time should not exceed 4 h; the hard drying time should not exceed 24 h.

(4) Impact resistance: It should be tested as per GB/T20624.1 with a spherical punch of 20±0.3 mm in diameter. The mass of the heavy punch is 1 kg without depth control ring, and the heavy punch is adjusted to fall from the position with a height of 500 mm. The punching point test is determined to be passed if there is no paint film falling-off or crack in the punched deformation area. Two test panels should be tested with 5 points on each panel. The test item can be determined to be passed if there is no paint film falling-off or crack at 3 points or more of one test panel.

(5) Adhesive force: It should be tested as per GB/T5210 with adhesive force of not less than 3 MPa.

(6) Abrasion resistance: It should be tested as per GB/T1768 with the rubber abrasion wheel of CS-10, and the weightlessness should not exceed 100 mg at 500 g per 500 circles.

(7) Salt water resistance: It should be tested as per GB/T10834 with nature seawater or artificial seawater at 27±6℃ for 48 h, and the paint film should be free of blistering, rusting or falling-off.

(8) Oil resistance: It should be tested as per GB/T9274 in the #0 diesel oil for 48 h, and the paint film should be free of blistering or falling-off.

(9) Sodium dodecyl benzene sulfonate resistance: It should be tested as per GB/T9274 in the sodium dodecyl benzene sulfonate solution with medium of 1% for 48 h, and the paint film

should be free of blistering or failing-off.

(10) Salt mist resistance: It should be tested as per GB/T1771 for 400 h and 1000 h for single-component paint and bi-component paint respectively, and the paint film should be free of blistering, falling-off or rusting.

(11) Artificial weathering aging: For ultraviolet aging, it should be tested as per GB/T14522 with irradiance of 0.68 W/m^2 for ultraviolet UVB-313 of 300 h or the agreed time; for xenon arc aging, it should be tested as per GB/T1865 for 500 h or the agreed time. The paint film color change should not exceed grade 4, and efflorescence should not exceed grade 2 (which can be further agreed for epoxy paint), with crack degree of grade 0.

(12) Weather resistance: It should be tested as per GB/T9276, and the result evaluation should be conducted as per GB/T1766. After being insolated in the marine atmosphere for 12 months, the paint film color change should not exceed grade 4, and efflorescence should not exceed grade 2 (which can be further agreed for epoxy paint), with crack degree of grade 0.

(13) Skid resistance: For skid-resistance deck paint, the dry friction factor of such paint to the rubber should be determined, and the rubber should be the vulcanized one with hardness of 60-80 (Shore A). It should be tested as per 5.2 of GB/T9263 by applying a load of 15 Kg uniformly to the test panel, and the dry friction factor should not be less than 0.85.

5.9 Oil tank paint for ship

5.9.1 The oil tank paint for ship should match the shop primer, anti-rusting paint and interlayer paint, and the complete supporting cargo hold paint system should consist of shop primer, anti-rusting paint, interlayer paint and finishing paint. The test items of the oil cargo hold paint and chemical tank paint should be determined according to the actual product carried. The substrates for drying time and flexibility test, abrasion performance test, impact resistance and salt mist resistance test as well as the adhesive force test are tin plate, glass pane or aluminum plate, steel plate and steel plate or metal test column respectively. Unless otherwise specified, one layer of coating should be applied for the three test items, namely, the drying time, flexibility and impact resistance (single component) with dry film thickness of (20~26)μm, and two layers (with an application interval of 24 h) for abrasion resistance test with dry film thickness of (70~80)μm; the adhesive force test should be conducted after the primer and finishing paint are matched with an application interval of 24 h, dry primer film thickness of (35~40)μm, dry finishing paint film thickness of (35~40)μm, and total dry film thickness of (70~80)μm. The salt mist test should be conducted after the primer and finishing paint are matched with an application interval of 24 h, dry primer film thickness of (75~100) m, dry finishing paint film thickness of (75~100) m, and total dry film thickness of (150~200) m.μμμ The single-component paint and bi-component paint should be maintained for 48 h and 7 d respectively first before being tested.

5.9.2 The test items and result requirement are as follows:

(1) Paint film appearance: Conduct visual inspection on the test panel under scattering sunlight. It can be determined to be qualified if the coating film is uniform in color and free of blistering, shrinkage cavity or other defect.

(2) Drying time: It should be tested as per GB/T1728, and the surface drying time should not exceed 4 h; the hard drying time should not exceed 24 h.

(3) Adhesive force: It should be tested as per GB/T5210 with adhesive force of not less than 3 MPa.

(4) Abrasion resistance: It should be tested as per GB/T1768 with the rubber abrasion wheel of CS-10, and the weightlessness should not exceed 100 mg at 500 g per 500 circles.

(5) Flexibility: It should be tested as per GB/T1731 with flexibility of not more than 3 mm (applicable to single-component paint).

(6) Impact resistance: It should be tested as per GB/T1732 with impact resistance of not less than 40 cm.

(7) Salt mist resistance: It should be tested as per GB/T1771, and the result evaluation should be conducted as per GB/T1766. The single-component paint should be free of peeling after 500 h, with allowable discoloring, blistering and rusting degrees of not more than grade 3, 1(S2) and 1(S3) respectively; the bi-component paint should be free of peeling after 1000 h, with allowable discoloring, blistering and rusting degrees of not more than grade 3, 1 (S1) and 1 (S1) respectively.

(8) Sanitary requirement: The paint of the cargo hold used to carry bulk cereal foods should not contaminate the goods, or harm the human body, which should be provided with sanitation inspection report issued by the test agency approved by the state. The paint of the refrigerated cargo hold should not release odour that may contaminate or corrode the goods.

5.10 Internal compartment finish coating

5.10.1 The paint, varnish or other decorative finish coating used on the exposed surface should not cause excessive smoke or toxic products, which should comply with Regulations 3, 5 and 6, Chapter II-2 of SOLAS Convention, 1974, as Amended, as well as IMO 2010 FTP Code Parts 2 and 5.

5.10.2 Fineness, appearance and color: Fineness should be tested as per GB/T1724, appearance and color should be tested by visualization. It should meet the technical requirement of product.

5.10.3 Organic content : It should meet the technical requirement of product, and tested as per IMO 2010 FTP Code Part 1.

5.11 Drinking water tank coating of shipbuilding

5.11.1 The drinking water tank coating of shipbuilding should be safe to human body and not be used together with the shop primer containing such toxic materials as the lead or chrome.

5.11.2 The composition of the drinking water tank paint system should be determined by the manufacturer, and the coating performance and test method specified below refer to those of the supporting drinking water tank paint system. The test items and result requirement are as follows;

(1) Fineness: It should be tested as per GB/T1724 with fineness of not more than 70μm.

(2) Adhesive force: It should be tested as per GB/T5210, with adhesive force of not lower than 3 MPa between the coating and substrate and between coatings. The coating film preparation should meet the technical requirement of product.

(3) Drying time: It should be tested as per GB/T1728, and the surface drying time should not exceed 4 h; the hard drying time should not exceed 24 h.

(4) Flexibility: It should be tested as per GB/T1731 with flexibility of not more than 5 mm.

(5) Salt mist resistance: It should be tested as per GB/T1771, and the coating should be free of blistering, falling-off or rusting after salt mist test for 600 h without interruption.

(6) Water resistance: It should be tested as per GB/T1733, and the coating should be free of blistering, rusting or peeling after being immersed in distilled water of 25±1℃ for 700 h.

(7) Sanitary requirement: It should be provided with sanitation inspection report issued by the test agency approved by the state. It should be conducted as per Annex A of GB5369. The immersing water should meet the requirement of domestic drinking water sanitary standard, and the dissolved substance should also be tested as per the paint ingredient. The dissolved toxic substance from the immersing water and coating should be subject to toxicological test, so as to guarantee it is safe to human body.

(8) Solid content : It should be tested as per GB/T1725 with solid content of not less than 70%.

5.12 Ballast tanks paint for ship

5.12.1 The expected lifetime of the ballast tanks paint for ship is 15 years, and product is divided into the epoxy group coating system and non epoxy group coating system as per the base stock and curing agent component.

5.12.2 Separate ballast tanks paint for ship:

Nonvolatile content(tested as per GB/T1725), density(tested as per GB/T6750), component identification on base and curing agent(tested as per GB/T6040): It should meet the technical requirement of product.

5.12.3 Complete ballast tanks paint for ship system;

(1) The test items and result requirement of the complete ballast tanks paint for ship system are as follows:

① Appearance and color: The paint film should be smooth. For multiple coating system, there should be color difference between coatings, and the top coating should be in light color.

② Nominal dry film thickness: Tested as per GB/T13452.2. The coating thickness of the epoxy group coating system should reach 320 μm as per 90/10 rule, and the non epoxy group coating system should meet the technical requirement of product. The average dry film thickness of the test panel should not exceed 15% of the nominal value.

③ Test on simulated ballast tank conditions: The test condition and requirement should comply with Appendix 5 "Test on Simulated Ballast Tank Conditions of Ballast Tanks Paint for Ship".

④ Condensation chamber test: The test condition and requirement should comply with

Appendix 6 "Condensation chamber test on ballast tanks paint for ship".

⑤ Compatibility with shop primer: The test on simulated ballast tank conditions and condensation chamber test should involve the shop primer. After such tests are passed, the approval certificate should specify the supporting shop primer and ballast tank coating (such shop primer should be that approved by CCS). The test on simulated ballast tank conditions and condensation chamber test can also be conducted on the processed bare steel plate without the shop primer, which, after being passed, can only be used on the processed bare steel plate as indicated in the approval certificate.

If a type of shop primer is part of the ballast tank coating system and has passed the test on simulated ballast tank conditions and condensation chamber test, such primer can be used together with other epoxy coating that has passed the test on simulated ballast tank conditions and condensation chamber test, provided that such primer is approved by the main coating supplier with respect to compatibility and has passed the test under no wave condition specified in Article 1.7 of Annex 5 (also called as the "crossover test").

(2) If the coating meets the following two conditions, it can be used as the alternative scheme of that mentioned in 5.12.3(1), and the alternative scheme adopted should be noted in the certificate. CCS may not accept a secondary alternative scheme based on the situation in the future. As a result, such approval certificate may be invalid or the manufacturer may be required to conduct test again as per the requirement of 5.12.3(1).

① The verification on 5-year field exposure should be conducted as per the following requirements:

(a) Check the record of the coating manufacturer to confirm that the coating system has been subject to field exposure for 5 years.

(b) Conduct joint test on all ballast tanks of the selected ship (by the coating manufacturer and CCS), so as to confirm it meets the requirements of Items a and e. The coating manufacturer representative should have at least 2-year coating experience with such inspector qualification as NACE-II or FROSIO-III, or other equivalent qualification accepted by competent authorities.

(c) The ballast tanks of the selected ship should be those under normal operation, with at least one tank with capacity of around 2000 m^3, at least one tank close to the heated liquid tank, and at least one tank under the deck exposed to the sunlight.

(d) If the selected ship fails to meet the requirement of Item c, clear limits should be provided in the approval certificate. For example, relevant coating cannot be used in the tank close to the heated liquid tank, the tank under the deck or the tank with capacity of more than the size to be inspected.

(e) All the ballast tanks should be in good conditions, and the coating has not been subject to repatching or repairing for the past 5 years. Good condition definition: There are only dotted tiny rust spots with allocation of less than 3% of the area calculated, without any visual coating damage. Rustiness at the edge or weld seam should cover less than 20％ of the edge or weld seam included in the calculated area. For the sample report on the coating status in the calculated area, see Annex 1 of IACS REC.87. If the NDFT used is bigger than that required in PSPC, it should be the

min. thickness used during production, which should be noted clearly in the approval certificate.

② The coating approved by Marintek B1* should meet the following requirements: Such coating should be applied as per Table 1 of PSPC rather than in the conditions adopted for approval test that are different from the PSPC, unless they are more stringent than those in Table 1 of PSPC.

5.13 Engine room bottom coating

The engine room bottom coating should match with the shop primer, and the test items and result requirement are as follows:

(1) Fineness: It should be tested as per GB/T1724 with fineness of not more than 80 μm (except for the flake coatings).

(2) Solid content: It should be tested as per GB/T1725, and the mass fraction of the nonvolatile matter should not be less than 70%.

(3) Drying time: It should be tested as per GB/T1728, and the surface drying time should not exceed 8 h; the hard drying time should not exceed 24 h.

(4) Adhesive force: It should be tested as per GB/T5210 with adhesive force of not less than 3 MPa.

(5) Salt mist resistance: It should be tested as per GB/T1771, and the paint film should be free of blistering, fracturing, peeling, wrinkling or rust spot after salt mist test for 600 h without interruption.

(6) Hot saline water resistance: It should be tested as per GB/T10834 at 40±2℃ in the hot saline water for 336 h, and the paint film should be free of blistering, fracturing, peeling, wrinkling or rust spot.

(7) Diesel resistance: It should be tested as per GB/T9274 at 23±2℃ for half a year, and the paint film should be free of blistering, softening, peeling, or rust spot.

5.14 Oil tank paint for ship

The test items and result requirements of the oil tank paint are as follows:

(1) Drying time: It should be tested as per GB/T1728 with the tin plate as the substrate for drying time test, and the surface drying time should not exceed 6 h; the hard drying time should not exceed 24 h.

(2) Coating film appearance: Conduct visual inspection on the test panel under scattering sunlight. It can be determined to be qualified if the coating film is uniform in color and free of blistering, shrinkage cavity or other defect.

(3) Adhesive force: It should be tested as per GB/T5210 with metal test column as the substrate, and the adhesive force should not be less than 3 MPa.

(4) Salt mist resistance: It should be tested as per GB/T1771, and the result evaluation is

conducted as per GB/T1766, and the coating should be free of blistering, rusting, or falling-off after salt mist test for 800 h without interruption (slight color change is allowed).

(5) Salt water resistance: It should be tested as per GB/T10834 with the test panel immersed in the saline at 23±2℃ for 7 d and then in the hot saline at 80±2℃ for 2h to complete a cycle, and three such cycles should be carried out. After that, the paint film should be free of blistering or falling-off.

(6) Oil resistance: It should be tested as per GB/T9274 in the #120 gasoline and #0 diesel oil at normal temperature for 21 d, and the paint film should be free of blistering, falling-off or softening.

5.15 Cargo oil tanks paint of crude oil tankers

5.15.1 The protective coating for the cargo oil tank of the crude oil tanker should meet the requirement of *Performance Standard of Protective Coatings for Cargo Oil Tank of Crude Oil Tanker (MSC.288 (87))*, and have the expected lifetime of 15 years.

5.15.2 Separate cargo oil tanks paint of crude oil tankers:

Non volatile content (tested as per GB/T1725), density (tested as per GB/T6750), component identification on base and curing agent (tested as per GB/T6040): It should meet the technical requirement of product.

5.15.3 Protective coating for the cargo oil tank of the crude oil tanker:

(1) Appearance and color: For multiple coating system, there should be color difference between coatings, and the top coating should be in light color.

(2) Nominal dry film thickness: Tested as per GB/T13452.2. The coating thickness of the epoxy group coating system should reach 320 μm as per 90/10 rule, and the non epoxy group coating system should meet the technical requirement of product.

(3) Gas-tight chamber test simulating the crude oil tank vapor phase in loading condition: The test condition and requirement should be in line with Appendix 7 "Gas-tight chamber test simulating the vapor phase of the loaded cargo tank" of the Guideline.

(4) Immersion test simulating the loaded condition of the crude oil tank: The test condition and requirement should be in line with Annex 8 "Immersion test simulating the loaded condition of the crude oil tank" of the Guideline.

(5) Compatibility with shop primer: The gas-tight chamber test and immersion test should involve the shop primer. After such tests are passed, the approval certificate should specify the supporting shop primer and cargo oil tank coating (such shop primer should be that approved by CCS). The gas-tight chamber test and immersion test can also be conducted on the processed bare steel plate without the shop primer, which, after being passed, can only be used on the processed bare steel plate as indicated in the approval certificate.

If a type of shop primer is part of the coating system of cargo oil tank of the crude oil tanker and has passed the gas-tight chamber test and immersion test, such primer can be used together with other epoxy coating that has passed the gas-tight chamber test and immersion test, provided that

such primer is approved by the main coating supplier with respect to compatibility and has passed the immersion test specified in Appendix 8 or the relevant test according to Performance Standard on the Protective Coatings in the Dedicated Seawater Ballast Tanks of All Ships and at Both Sides of the Bulk Cargo Ship.

5.16 All marine coatings shall not contain any asbestos.

6 Materials and components

6.1 The list of qualified main raw material suppliers should be submitted to CCS for information, which should specify the name, model/specification, control method and supplier name of main raw material (such as the resin, curing agent and anti-fouling active substances) affecting the main performance of the product.

6.2 Any change to the main raw material involved in the list of qualified suppliers should be informed to CCS, and the manufacturer should guarantee the formula of the product produced currently is the same with that produced after the approval certificate is obtained; otherwise, the certificate will be revoked.

7 Type test

7.1 The type test should be conducted as per the test program approved by CCS, and the test program should be agreed by the applicant and CCS.

7.1.1 Test program should specify the name, type test item, test method and relevant technical index, technical standard, test site, handling principle on test disqualification of the product to be approved.

7.1.2 The test result should meet the requirements of the Guideline and/or technical conditions for product inspection and acceptance/enterprise standard.

7.1.3 Handling principle on test disqualification: If any item fails to pass the test, the same sample can be used for retest. If the retest still fails, resampling can be conducted after being approved by CCS for another test on all items specified.

7.2 Test sample selection and preparation:

7.2.1 The test sample should be selected from the production line or finished product warehouse of the manufacturer under the supervision of CCS Surveyor, and then marked, sealed and recorded. The sample identification mark should include manufacturer name, sample name, model and batch number, production date and sampling date, total quantity of the products delivered, sampling site and sampling person.

7.2.2 The test sample should be stored and used as per the condition and sample management regulations of the manufacturer, and the quantity should be sufficient to complete all the tests and retest (if necessary). If the sample is used to evaluate the test capacity of the manufacturer, the same sample selected should be sent to the test room of the manufacturer and the test verification agency approved or accepted by CCS respectively for test on same items.

7.2.3 For panels to be prepared before being sent out, the preparation should be conducted with the witness of CCS Surveyor, and proper parameters should be recorded, including the shop primer,

coating layers, coating interval, dry film thickness, thinner, humidity, ambient temperature, and steel plate temperature. The dry film thickness of the coating should meet the requirement of relevant standard and be in line with the suggested value of the coating manufacturer, and the composition of the supporting system should be determined by the coating manufacturer.

7.2.4 For the same coatings produced by the same manufacturer at different locations, it is not necessary to conduct separate type test on the coating produced at each location provided that the manufacturer can prove that they are the same coating (by means of infrared analysis and specific gravity test).

7.2.5 Winter-type coating and summer-type coating are deemed to be different coatings, unless they are proved to be the same via infrared (IR) identification or specific gravity (SG) test.

7.3 Test site:

The test sample should be sent to the test agency approved or accepted by CCS for type test. The test can be carried out in the test room of the manufacturer with the witness of CCS Surveyor after being approved by CCS if the manufacturer has complete and valid inspection and test equipment as well as trained and qualified test personnel, except the test for initial approval or that used to compare the results of the test on same items from the manufacturer and the test inspection agency to evaluate the reliability of the manufacturer to conduct relevant test under current conditions.

7.4 Type test items

7.4.1 The test should be conducted as per the test program approved by CCS. For test items, see "List of test items on ship coating type test" (see Table 7.4.1). Those marked with X are the type test items, which can be adjusted according to actual situations.

7.4.2 If the product is applied for multiple applications, the type test items should involve the test items of the coatings applied for multiple applications.

7.4.3 For the weather resistance test on boottopping paint for ship, topside paint and deck paint as well as the shallow sea immersion test on the anti-fouling paint for ship hull, if the manufacturer can provide the original test report or application proof, CCS can accept the results of the artificial weathering aging test and the dynamic simulation test on anti-fouling paint as the temporary basis for issuing the certificate based on the evaluation on the quality management system for product R&D and application of the manufacturer. Meanwhile, the weather resistance test and shallow sea immersion test should continue. If the test result is unacceptable, such type approval will be canceled. The manufacturer should provide guarantee for recalling the products delivered if the test result is unacceptable.

List of ship coating type test items **Table 7.4.1**

S/N			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Type test items	Test method Standard adopted	Shop primer for shop building	Anticorrosive paint for ship hull, Tie paint for ship hull	Marine anti-fouling paint	Anodic shielding coating	Marine anticorrosive paint	Bootopping paint for ship	Topside paint	Deck paint	Oil tank paint for ship	Internal compartment finish coating	Drinking water tank coating of shipbuilding	Ballast tanks paint for ship	Engine room bottom coating	Oil tank paint for ship	Cargo oil tanks paint of crude oil tankers
1	Coating fineness																
		GB/T1724							X			X	X		X		
2	Drying time	GB/T1728	X	X	X	X	X	X	X	X	X				X	X	
3	Solid content	GB/T1725					X		X	X				X	X		X
4	Density	GB/T6750		X	X	X	X							X			X
5	Non volatile content volume	GB/T9272		X	X												
6	Adhesive force	GB/T1720	X														
		GB/T5210		X		X	X	X	X	X	X		X		X	X	
7	Flexibility	GB/T1731					X		X		X		X				
8	Abrasion resistance	GB/T1768								X	X						
9	Paint film color and appearance			X	X	X		X	X	X	X	X		X		X	X
10	Viscosity	GB/T1723 or 9269 and 9751.1		X	X		X										
11	Impact resistance	GB/T 20624.1						X	X	X							
		ASTM D2794				X											
		GB/T1732									X						
12	Salt water resistance	GB/T10834					X	X	X	X					X	X	

Continued Table 7.4.1

S/N			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Type test items	Test method Standard adopted	Shop primer for shop building	Anticorrosive paint for ship hull, Tie paint for ship hull	Marine anti-fouling paint	Anodic shielding coating	Marine anticorrosive paint	Boottopping paint for ship	Topside paint	Deck paint	Oil tank paint for ship	Internal compartment finish coating	Drinking water tank coating of shipbuilding	Ballast tanks paint for ship	Engine room bottom coating	Oil tank paint for ship	Cargo oil tanks paint of crude oil tankers
13	Salt mist resistance	GB/T1771				X	X	X	X	X	X		X		X	X	
14	Water resistance	GB/T1733											X				
15	Oil resistance	GB/T9274						X		X					X	X	
16	Weather resistance	GB/T9276	X					X	X	X							
17	Artificial weathering aging	GB/T14522 or GB/T1865						X	X	X							
18	Welding and cutting	GB/T6747	X														
19	Paint film thickness	GB/T13452.2	X											X			X
20	Metal zinc content in the nonvolatile content	HG/T3668	X														
21	Stroke resistance	GB/T 9260						X									

Continued Table 7.4.1

S/N			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Type test items	Test method Standard adopted	Shop primer for shop building	Anticorrosive paint for ship hull, Tie paint for ship hull	Marine anti-fouling paint	Anodic shielding coating	Marine anticorrosive paint	Boottopping paint for ship	Topside paint	Deck paint	Oil tank paint for ship	Internal compartment finish coating	Drinking water tank coating of shipbuilding	Ballast tanks paint for ship	Engine room bottom coating	Oil tank paint for ship	Cargo oil tanks paint of crude oil tankers
22	Sodium dodecyl benzene sulfonate resistance	GB/T 9274								X							
23	Low flame-spread characteristics, smoke and toxicity	IMO 2010 FTP Code Parts 2 and 5										X					
24	Flash point	GB/T 5208		X	X		X										
25	Gloss	GB/T 9764							X								
26	Immersion resistance	GB/T 10834		X													
27	Blistering resistance	GB/T 10834		X													
28	Cathodic disbonding resistance	GB/T7790		X													
29	Anti-fouling composition(Copper)	GB/T31409			X												
30	Shallow sea immersion	GB/T5370			X												
31	Anti-fouling coating polishability	GB/T31411			X												
32	Dynamic simulation test	GB/T7789			X												
33	Applicability with finishing coat	GB/T1727					X										
34	Potential resistance	GB/T7788				X											
35	Skid resistance	GB/T9263								X							
36	Sanitary requirement	GB5369									X		X				
37	Component identification	GB/T6040												X			X
38	Test on compatibility with shop primer	MSC.215(82)												X			X
39	Test on simulated ballast tank conditions	MSC.215(82)												X			

Continued Table 7.4.1

S/N			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Type test items	Test method Standard adopted	Shop primer for shop building	Anticorrosive paint for ship hull, Tie paint for ship hull	Marine anti-fouling paint	Anodic shielding coating	Marine anticorrosive paint	Boottopping paint for ship	Topside paint	Deck paint	Oil tank paint for ship	Internal compartment finish coating	Drinking water tank coating of shipbuilding	Ballast tanks paint for ship	Engine room bottom coating	Oil tank paint for ship	Cargo oil tanks paint of crude oil tankers
40	Condensation chamber test	MSC.215(82)												X			
41	Gas-tight chamber test	MSC.288 (87)															X
42	Immersion test	MSC.288 (87)															X

8 Unit/batch inspection

8.1 The quality and consistence with that at initial approval of the approved product will be confirmed by CCS via regular review, and no product unit/batch inspection will be conducted or certificate issued. The manufacturer can deliver goods as per the copy of the approval certificate or manufacturer's quality proof document. If it is necessary or the user requires the product certificate, the product to be approved will be inspected and certificate issued as per the inspection plan confirmed during approval after the manufacturer submits the inspection application.

8.2 For unapproved coating products, CCS will not conduct the unit/batch inspection unless the unit/batch inspection is subject to process confirmation, site supervision, and process record review, and the type test items are passed.

9 Site audit

9.1 Based on the approval test, the CCS Surveyor conducts the quality assurance system verification in the manufacturer's production sites such as relevant departments, workshops, labs and warehouses, so as to confirm that product manufacturing and relevant control are performed according to rules of the submitted documents and are in line with applicable regulations, to check for the actual organization structure and interrelationship involved in the approval scope of the applicant as well as the human resources, to verify validity of main manufacturing equipment of the approved products, to ensure conformance, sufficiency and effectiveness of the quality assurance system, to witness conformity of inspection and testing on the manufacturer's products, and to validate the control procedures and rules on procurement and supplier selection & evaluation for establishment and implementation of documentation. Requirements for the coating manufacturer:

(1) The manufacturer should be provided with production equipment and testing instruments meeting requirements of product manufacturing and quality control, labs, measuring room and corresponding testing means suitable to the environmental conditions, and the physicochemical property test personnel that have been trained properly and granted with qualification certificates corresponding to their tasks; besides, the testing instruments within validity of measurement should meet the requirements of delivery test with respect to category and accuracy.

(2) Any adjustment beyond the limit listed in the QC Instructions below will not be accepted unless otherwise tested by the Coating System Development Plan or confirmed by the follow-up testing, except for "Increase proportionally" from the lab testing to the beginning of mass production. The adjustment must be agreed by the Formula Technical Center.

(3) In case of formula adjustment during production, the max. allowable dosage should be approved by the Formula Technical Center and marked in the QC working procedure clearly.

(4) The manufacturer's quality control system should guarantee that the products produced currently and those produced after the approval certificate is obtained share the same formula. The formula change is allowed only when retesting has been carried out as per relevant rules and corresponding approval certificate has been issued by CCS.

(5) Batch production records, including such test results as viscosity, specific gravity and airless spraying characteristics, should be recorded in exact details. Any other additional test items should also be recorded in details.

(6) Whenever practicable, raw material source and distribution of each batch of coating should be traceable. However, it does not apply to bulk materials such as solvent stored in the tank or preliminarily-dissolved solid epoxy; in this case, it is possible to record ingredients of the supplier only.

(7) Date, batch No. and quantity specified in each coating contract should be recorded clearly.

(8) The packing drum should be clearly marked with details required by the CCS approval certificate, including name, model, and approval certificate No.

(9) The manufacturer should establish the sample retention system for retention and proper storage of samples from each batch of products.

9.2 In case of nonacceptance during verification, notify the manufacturer's responsible personnel to take corrective measures that will be followed up and validated.

Appendix:

Appendix 1: Welding and Cutting Test on the Shop Primer for Shop Building

Appendix 2: Determination Method on the Total Tin Content and Organotin Content in the Anti-Fouling Paint for ship hull

Appendix 3 Environmental Risk Assessment Method of Anti-Fouling Active Substances in Anti-Fouling Paints

Appendix 1 Welding and Cutting Test on the Shop Primer for Shop Building

1 Test on effect of shop primer for shop building on welding performance

1.1 Test condition:

(1) Test panel: The marine steel plate, 20 mm in thickness, is used as the test panel.

(2) Welding materials: See Table 1.1.1 in Rules for Materials and Welding for grades of welding materials and steel used for testing.

Table of grades of welding materials and steel used for testing Table 1.1.1

Grade of welding material	Grade of steel used for testing	Grade of welding material	Grade of steel used for testing	Grade of welding material	Grade of steel used for testing
1	A	4Y42	E420	3Y62	D620
2	B, D	5Y42	F420	4Y62	E620
3	E	3Y46	D460	5Y62	F620
1Y	AH32, AH36	4Y46	E460	3Y69	D690
2Y	DH32, DH36	5Y46	F460	4Y69	E690
3Y	EH32, EH36	3Y50	D500	5Y69	F690
4Y	FH32, FH36	4Y50	E500	0.5Ni	0.5Ni
2Y40	DH40	5Y50	F500	1.5Ni	1.5Ni
3Y40	EH40	3Y55	D550	3.5Ni	3.5Ni
4Y40	FH40	4Y55	E550	5Ni	5Ni
3Y42	D420	5Y55	F550	9Ni	9Ni

(3) Welding method: Manual electric arc welding or CO_2 welding.

(4) Surface state of test panel: After cutting, the test panel is subject to groove processing and sandblasting (or shot blasting) such that it reaches Sa2½ level criterion. Then, the shop primer will be applied to required parts, including groove.

(5) The thicknesses of paint film are as follows: Level A: paint coating is performed as per the manufacturer's instruction; Level B: thickness of paint film is about two times that required in the manufacturer's instruction; Level C: sandblasting is required rather than paint coating.

(6) Type of test panel connector: Butt welding, fillet welding.

① Butt welding: The butt welding test panel should be subject to flame cutting such that its width is not less than 150 mm and its length is sufficient for preparation of samples of specified quantity and size. Then, the samples will be subject to paint coating as per the levels A/B/C criteria and assembled after the shop primer for shop building has dried. Step: The flat butt welding with 4 mm welding rods will be applied. Full welding should be performed, with root chipped on the opposite side, bottom welded with 4 mm welding rods, and height of weld reinforcement on the front and back of not more than 3 mm. Based on Rules for Materials and Welding, 2 samples will be prepared for transverse tensile test, 2 samples for forward and backward bending test, and 3 sets of samples (3 pcs per set) for impact test.

② Fillet welding: Apply the paint as per Levels A&B criteria (but not apply the paint as per Level C criterion), and then assemble and weld the test panel in such a way that its width is 150 mm and its length is sufficient for welding of the whole length of the welding rod

with max. diameter.

1.2 Requirement of test result

1.2.1 Requirement of butt welding test items and results

(1) Visual inspection: At the time of observation of the full length of weld seam via 5X magnifier, the weld seam should be uniform and free from such defects as crack, obvious overlap or undercut in appearance.

(2) Nondestructive test: The weld seam should be free from unacceptable defects inside.

(3) Inspection of mechanical properties, as shown in Table 1.2.1:

① Tensile test: 2 samples for transverse tensile test, with tensile strength not lower than min. tensile strength required by the base material.

② Forward and backward bending test: One sample for forward/backward bending test respectively, with crack or concavity of no more than 3 mm on the sample surface subject to tension.

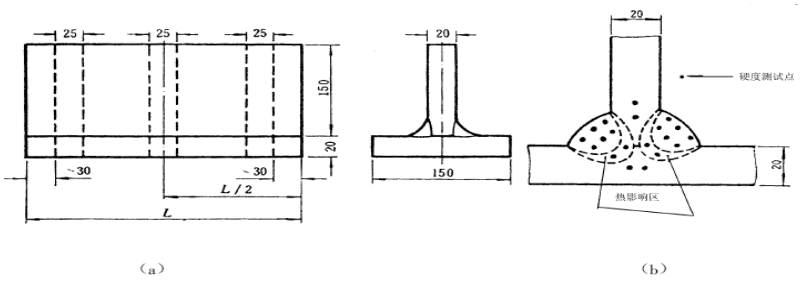
③ Impact test: 3 sets of samples (3 pcs per set), with notches located respectively at the center of weld seam, on the weld junction, and in the heat-affected zone 2 mm away from the weld junction. Single impact test result should not be less than 70% of the specified value, with each of the three mean values being larger than the specified value.

Mechanical properties of structural steel welding material Table 1.2.1

Grade of welding material			**1, 2, 3**	**1Y,2Y 3Y, 4Y**	**2Y40 3Y40 4Y40**	**3Y42 4Y42 5Y42**	**3Y46 4Y46 5Y46**	**3Y50 4Y50 5Y50**	**3Y55 4Y55 5Y55**	**3Y62 4Y62 5Y62**	**3Y69 4Y69 5Y69**
Butt welding test	Tensile strength of connector %(N/mm^2)		≥400	≥490	≥510	≥530	≥570	≥610	≥670	≥720	≥770
	Charpy V-notch impact test	Test temperature (℃)	1. Impact test temperatures of welding materials with grade 1Y, grades 2/2Y/2Y40, grades 3/3Y/3Y40/3Y42/3Y46/3Y50/3Y55/3Y62/3Y69, grades 4Y/4Y40/4Y42/4Y46/4Y50/4Y55/4Y62/4Y69, and grades 5Y42/5Y46/5Y50/5Y55/5Y62/5Y69 are 20℃, 0℃, -20℃, -40℃ and -60℃ respectively.								
	Charpy V-notch impact test	Average impact work (J)	≥47								
	Bending test		After testing, the crack or other defect on the sample surface should not be longer than 3 mm.								

1.2.2 Requirement of fillet welding test items and results

(1) Based on Rules for Materials and Welding, prepare 3 samples of 25 mm in length for macro examination on their sections, as shown in Fig. (a).



(2) Hardness test: Polish end faces of the three samples subject to macro examination on the sections, and then perform the hardness test therein.

(3) Rupture test of fillet seam: For the remaining two subsections, take one subsection and groove or plane the fillet seam at the first side, and take the other subsection and groove or plane the fillet seam at the second side. Weld seams should be fused well without crack, looseness or other defects on the ruptured face. In case of slag inclusion or pore in the weld seam, quantity, size, position and density of the defect should be recorded in the report that will be submitted for verification by CCS. Fillet weld seams should be fused well with proper formation of weld.

1.2.3 Result requirement: After the above testing, the test results are in line with Rules for Materials and Welding and the above requirements, and the welding test data obtained after paint coating based on Levels A&B criteria differ from those based on Level C criterion (i.e. without paint coating) slightly, indicating that paint coating prior to welding does not affect the welding adversely.

1.3 Test report

It should cover name of manufacturer, name/identification of shop primer, batch No., data on steel plate surface treatment, test unit, test date as well as contents in the table below:

Test records **Table 1.1.3.1**

No.	Connector type	Welding method	Quantity (set)	Test panel material	Test panel size (mm)	Welding material	Grade of steel plate	Design thickness of film	Measured film thickness (μm)
1-1	Butt welding	Manual welding	1					Level A	
1-2			1					Level B	
1-3			1					Level C	
1-4	Fillet welding		1					Level A	
1-5			1					Level B	
1-6			1					Level C	

Test report on mechanical properties of butt welding test panel Table 1.1.3.2

Test panel No.	Welding position	Transverse tensile test		Cold bending test (180o)		Impact test			
		Tensile strength	Fracture position	Forward bending	Backward bending	Notch position	Impact work (J)		
1-1	Butt welding					Weld seam center			
						Juncture			
						Heat-affected area			
1-2	Butt welding					Weld seam center			
						Juncture			
						Heat-affected area			
1-3	Butt welding					Weld seam center			
						Juncture			
						Heat-affected area			

Test equipment Table 1.1.3.3

Test equipment	Model	Equipment No.	Equipment validity period
Welding equipment			
Universal material testing machine			
Impact test machine			
Hardness tester			

2 Test on effect of cutting on the film of the shop primer for shop building

2.1 Test conditions: 2 test panels of 305 mm*300 mm*20 mm; cutting requirement: test panel is cut into pieces of 150 mm*305 mm at the oxygen pressure of not more than 0.6 Mpa and cutting speed of 20 cm/min.

2.2 Test result and acceptance standard: The decrease of cutting speed should not exceed 15% and the damaged paint film at both sides of weld seam or cutting seam should not exceed 20 mm in width, provided that the test is performed after the shop primer for shop building has been applied according to paint film thickness requirements given in the manufacturer's instructions.

2.3 Test report: It should cover name of manufacturer, name/identification of shop primer, batch No., data on steel plate surface treatment, test date, cutting machine model, test panel size, as well as contents in the table below:

Test report **Table 1.2.3**

Cutting seam No.	Cutting nozzle No.	Fuel gas pressure (Mpa)	Oxygen pressure (MPa)	Cutting speed (cm/min)	Distance between cutting nozzle and workpiece (mm)	Cutting seam width (mm)	Paint film width affected (mm)
1							
2							

Appendix 2: Determination Method on the Total Tin Content and Organotin Content in the Anti-Fouling Paint for Ship Hull

This test is made according to *International Convention on Control of Harmful Anti-fouling Systems on Ships* of IMO, as well as Annex of MEPC.104(49) *Guideline for Brief Sampling of Anti-fouling System on Ships*: *Applicable Method of Brief Sampling and Analysis of Anti-fouling System on Ships - Organotin*.

1 Method 1

This method is to identify the organotin compounds quickly that act as biocide of the hull anti-fouling system. It has two steps for analysis: Step 1: measure the total tin content of organotin; Step 2: measure the special organotin compounds. Step 2 need not be performed before Step 1 has been validated.

1.1 Sampling: Sample the two parts in a parallel manner, and then mark them as Sample A and Sample B clearly for testing of analysis procedure.

1.2 Analysis procedure

1.2.1 The two parts constituting the analysis procedure are shown in figure 2.1.4.1 below. The two parts or steps are as follows:

Step 1: Analyze the tin content of Sample A.

Step 2: Analyze Sample B with a sum of money paid and much time consumed, which cannot be performed before Step 1 has been validated. This test involves the organotin analysis via the derived gas chromatography/mass spectrum spectrophotometric method (GC/MS) and provision of various detailed data on the organotin.

1.2.2 Step 1 Analyze the total organotin contents of Sample A

For Sample A, the inductively coupled plasma/ mass spectrum spectrophotometric method (ICP/MS) is applied to analyze total tin content in 1 kg of dry paint (or total tin content in each sample), provided that the material has been solubilized by aqua fortis. It should be noted that any other scientifically recognized tin analysis procedure (e.g. AAS, XRF and ICP-OES) is acceptable.

1.2.3 Step 2: Organotin feature in Sample B

Analysis on Sample B: Qualitative and quantitative analysis on organotin compounds of Sample B should be performed if Sample A has been validated. It is advisable that Sample B is subject to the following analysis procedures:

(1) Extract the Sample B solvent in the ultrasonic bath via ultrasonic processing method;

(2) Derive the ethyl magnesium bromide;

(3) Remove the extracts.

(4) Make analysis via high resolution gas chromatography/mass spectrum spectrophotometric method (GC/MS); and

(5) Use the tripropyltinbromide as standard sample for quantitative analysis.

Any qualitative and quantitative analysis method of the organotin compounds with equivalent reliability is acceptable.

1.3 Limited and permissible scope

1.3.1 Limit: The limit value for a simple sampling method described herein is "1 kg dry paint contains 2500 mg Sn".

1.3.2 Permissible scope: The permissible scope is "1 kg dry paint contains 500 mg Sn (20%), excluding the limit value".

1.3.3 Organotin containing biocide or catalyst compounds

(1) Organotin compounds not acting as biocide: As stated in Annex of MEPC.102 (48) Resolution, if the organotin compounds do not act as biocide, a small part of them can be used as chemical catalyst (such as monosubstitution and disubstitution organotin compounds), provided that they conform to supplementary provision 1 of the convention.

(2) Inorganic impurities in paint ingredients: Consider the inorganic impurities in paint ingredients.

(3) Difference among various biocide anti-fouling paint: Currently, it is found that no concentrations of both organotin and inorganic impurities approach the limit standard (1 kg dry paint contains 2500 mg Sn) or reach a higher value. However, when the paint containing biocide is put into service, it is found that concentration of organotin compounds in dry paint is 50 000 kg Sn/kg. Therefore, it is probable that the anti-fouling paint systems containing organotin compounds as the biocide, no organotin compounds, and no organotin compounds in the concentration as biocide differ from each other.

1.4 Definition of conformity: procedure consisting of two steps:

1.4.1 The analysis and validation conforming to the convention are performed via a procedure consisting of two steps, as shown in the flow chart 2.1.4.1.

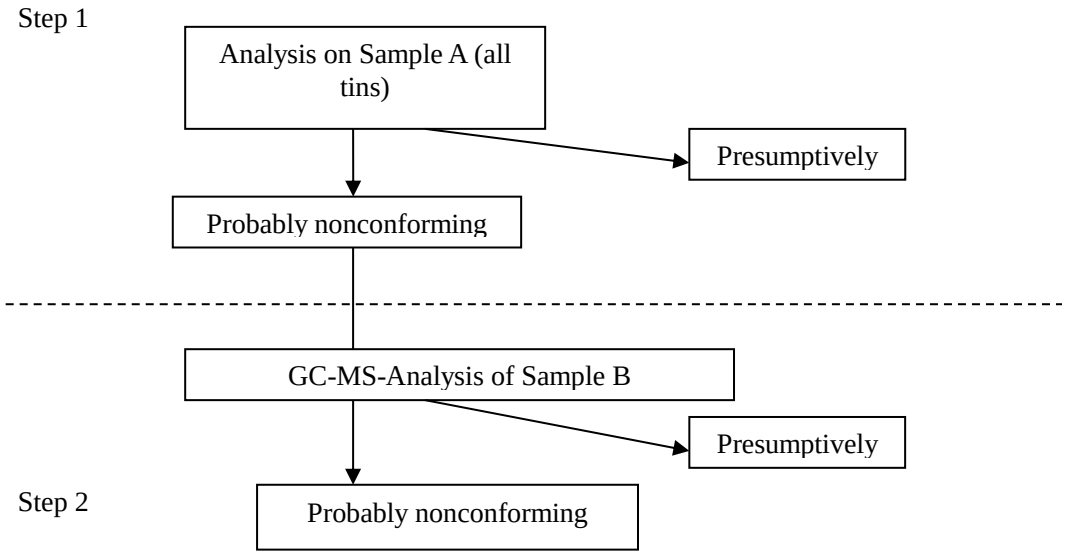


Fig. 2.1.4.1 Flow chart of analysis procedure consisting of two steps

1.4.2 Conformity of Step 1 - content scope

When analysis results of Sample A in Step 1 conform to the following requirements, assume that they conform to the convention:

(1) For tests on 25% of samples or less, total tin content in 1 kg dry paint exceeds 2500 mg (2500 mg Sn per kg of dry paint); and

(2) For tests on at least 8 samples, no test indicates that concentration of the total tin content exceeds the sum of limit value and permissible scope, i.e. no sample has the concentration of 3000 mg Sn per kg of dry paint or more.

Step 2 is unnecessary if the test result of sample A indicates that no organotin exists as the biocide.

1.4.3 Inconformity of Step 1 - content scope

Inconformity to 1.4.2 indicates that the result is unacceptable. Step 2 should be carried out and the sample marked as Sample B should be analyzed, so as to confirm and characterize the existing organotin (see Fig. 2.1.4.1).

1.4.4 Conformity of Step 2 - content scope

When analysis results of Sample B in Step 2 conform to the following requirements as well, assume that they conform to the convention:

(1) For tests on 25% of samples or less, total tin content in 1 kg dry paint exceeds 2500 mg (2500 mg Sn per kg of dry paint); and

(2) For tests on at least 8 samples, no test indicates that concentration of the total tin content exceeds the sum of limit value and permissible scope, i.e. no sample has the concentration of 3000 mg Sn per kg of dry paint or more.

1.4.5 Inconformity of Step 2 - content scope

In case of inconformity to 1.4.4, test results of Step 2 do not conform to the convention, implying existence of organotin compounds in the anti-fouling system, which can act as the biocide at a certain level.

2 Method 2

2.1 First-phase analysis

2.1.1 Assume that the first-phase analysis is performed at the inspection or check site, e.g. dry dock and harbor. In order to complete the site analysis, the X-ray fluorescence analysis (XRF) method is applied to measure the total tin content.

2.1.2 Such analysis features of measurement scope and accuracy scope mainly depend on types of instruments, e.g. X-ray tube, spectrometer and optical device (light filter or collimator). Among kinds of XRF instruments, one is the compact type capability dispersive spectroscopy capable of operation without liquid nitrogen and provided with silicon drift detector, which is preferred by the site analysis system. In case of analysis conducted in the lab, the wavelength dispersion system or solid-state detector can be used as well.

2.1.3 The software special for tin analysis can be used to help the Surveyor or port state control officer's (PSCO) operator to measure total tin content in the sample.

2.1.4 The software customized as required may require provision of standard curve of tin X-ray density feature related to the tin content (especially within 0.1%-0.5%) in advance.

2.1.5 One test piece (sample tray) will be placed in the instrument for sampling after preparations including warm-up of XRF instrument and startup of computer. Then, the customized software will be provided for analysis. Analysis of single test piece lasts for 5 min usually, with results displayed on the screen automatically.

2.1.6 Considering that XRF analysis has no effect on the sample performance, all test pieces collected (6-9 pcs) (including those used for second analysis and storage) can be provided for this analysis.

2.2 Description of first-phase analysis results

(1) XRF data of 6-9 test pieces can be obtained at each sampling point based on the above procedure. Average tin content can be calculated from the intermediate value (i.e. representative value of these sampling points) after the max. and min. values have been excluded.

(2) When the tin content (average value) in the sample does not exceed the sum of limit value (2500 mg per kg) and permissible quantity (500 mg per kg), assume that it conforms to the convention.

(3) In case that the average value of one or more samples from different sampling points does not conform to the above standard, these samples should be submitted to the lab for the second-phase analysis. Regardless of results, the second-phase analysis is allowed as long as the Surveyor or PSCO thinks it necessary.

2.3 Second-phase analysis

2.3.1 Considering that the second-phase analysis provides the final exact results on samples, the analysis method should be subject to thorough verification by specialists based on scientific evidences. Brief descriptions of temporary method for the second-phase analysis are listed below.

2.3.2 The total mass of the test piece collected, after removal of paint by sand paper, should be measured by an electronic scale with accuracy of 0.1 mg. The test piece is hydrolyzed by NaOH aqueous solution, extracted by organic solvent, and then derived by PrMgBr. Make analysis via high resolution gas chromatography/mass spectrum spectrophotometric method (GC/MS) after cleaning of extracts. For quantitative analysis, tetrabutyltin of d36 should be added if the internal standard is applied.

2.3.3 These analysises provide data on classifications and contents of chemicals (mg per kg of test piece). Organotin content is expressed in mg per kg of dry paint.

2.4 Judgment in consistence with the convention

2.4.1 Conformity to the convention: Assume conformity to the convention provided that results of the second-phase analysis meet the following requirements as well:

(1) For tests on 25% of samples or less, total organotin content in 1 kg dry paint exceeds 2500 mg (2500 mg Sn per kg of dry paint); and

(2) For tests on at least 8 samples, no test indicates that concentration of the total organotin content exceeds the sum of limit value and permissible scope, i.e. no sample has the concentration of 3000 mg Sn per kg of dry paint or more.

2.4.2 Inconformity to the convention: If results are inconsistent with the above standard, organotin compounds exist in the anti-fouling system that can be used as the biocide to a certain extent.

Appendix 3 Environmental Risk Assessment Method of Anti-Fouling Active Substances in Anti-Fouling Paints

1 Purpose

It aims to provide the Environmental Risk Assessment Method of Anti-Fouling Active Substances in Anti-Fouling Paints.

2 Assessment method

This method is based on supplementary provisions 2&3, AFS convention and ISO 13073-1 and makes reference to EU biocide product directive (BPD). It covers requirements of supplementary provisions 2&3, AFS convention with respect to assessment scope, and is equivalent to ISO 13073-1 with respect to assessment step and requirement.

3 Anti-fouling composition

3.1 Classification

The anti-fouling active substance in ship anti-fouling paint system can be divided into organic one and inorganic one with respect to essential property of material.

3.2 Basic data requirement of risk characterization of anti-fouling active substance

In order to carry out risk assessments, the applicant should provide corresponding data information by phases as per requirements in Table 3.3.1.

Most basic data information requirement on marine environment risk assessment of anti-fouling active substances in anti-fouling paint Table 3.3.2

Data item	Required data	Organic matter			Inorganic matter
		Phase 1	Phase 2		
			Step 1	Step 2	
Applicant	Name, address and contact	×	×	×	×
	Manufacturer and address	×	×	×	×
Identification of substance and product	Common name and synonym	×	×	×	×
	Chemical name (IUPAC)*	×	×	×	×

Continued Table 3.3.2

Data item	Required data	Organic matter			Inorganic matter
		Phase 1	Phase 2		
			Step 1	Step 2	
Identification of substance and product	CAS No. and other registration No.	×	×	×	×
	Molecular formula and structural formula*	×	×	×	×
	Molecular weight*	×	×	×	×
	Manufacturing method, substance purity, identification of material and precursor (e.g. UV/VIS, IR, NMR or MS)	×	×	×	×
	Identification of impurities and additives	×	×	×	×
Physicochemical properties	Melting point*, boiling point*, density*	×	×	×	×
	Vapor pressure*, flash point, and surface tension	×	×	×	×
	Physical state and color	×	×	×	×
	Solubility in water* (effect of pH and temperature)	×	×	×	×
	Thermal stability and decomposition product*	×	×	×	×
Testing method	Analysis method, recycling rate, and testing limits of pure substance, isomer, impurity, additive and decomposition product in environment — Sea water — Sea mud	×	×	×	×
	— Animal body tissue and food	×	×	×	×
Effect on target organism and expected application	Effect on fouling organism	×	×	×	×
	Effective concentration of substance representative of the product	×	×	×	×
	Leaching rate*and measuring method	×	×	×	×
	Mode of action (including time delay)	×	×	×	×
	User	×	×	×	×

Continued Table 3.3.2

Data item	Required data	Organic matter			Inorganic matter
		Phase 1	Phase 2		
			Step 1	Step 2	
Effect on target organism and expected application	Resistance encountered in development	×	×	×	×
	Annual output in the market (including import and production)	(×)	(×)	(×)	(×)
	Valid anti-fouling period	×	×	×	×
Ecotoxicity research	Acute toxicity, 50% lethal concentration or effective concentration, L(E)C_{50}* — Acute toxicity for fish — Acute toxicity for invertebrate — Growth inhibition for alga	×	×	×	×
	Chronic toxicity, $Chronic_{sed}$ is the lowest NOEC obtained from the long time test, 10% lethal concentration (LC_{10}) or 10% effective concentration (EC_{10})(mg/kg)* — Chronic toxicity for fish	×	×	×	×
	— Effect on reproduction and growth rate of fish*	×	×	×	×
	— Effect on reproduction and growth rate of invertebrate*	×	×	×	×
	Biological concentration (bioaccumulative factor, BCF)* — Biological concentration for fish and bioaccumulative*	×	×	×	×
	— Biological magnification at a suitable place*	**(×)**	**(×)**	**(×)**	**(×)**
	—Octanol/water distribution coefficient (K_{OW})* (effect of pH and temperature)	×	×	×	×
	Biological degradation (half-life period t)* — Biological degradation capability at a suitable place	**(×)**	**(×)**	**(×)**	**(×)**
	—Intrinsic biodegradability at a suitable place	**(×)**	**(×)**	**(×)**	**(×)**
	—Biodegradability in sea water	×	×	×	**(×)**

Continued Table 3.3.2

Data item	Required data	Organic matter			Inorganic matter
		Phase 1	Phase 2		
			Step 1	Step 2	
Ecotoxicity research	Abiotic degradation — Hydrolyzation under the effect of pH*	×	×	×	**(×)**
	— Photoconversion in sea water*	×	×	×	**(×)**
	Confirmation of degradation product			×	×
	Degradation of water and sediment in a suitable place*			**(×)**	**(×)**
	Killing activity of initial dose in degradation at a suitable place			**(×)**	**(×)**
	Screening test of absorption/desorption		×	×	×
	Distribution of sediment/water at the required place*		(×)	(×)	(×)
Research on toxicity of second poisoning and metabolism	Effect on birds (Tox_{pred} is the toxicity value of organism with high trophic level, expressed in mg/kg) — Food toxicity — Effect on reproduction			**(×)**	**(×)**
	Relevant data — Acute toxicity — Metabolism study — Toxicity of repeated dose — Chronic toxicity — Mutagenicity study —Carcinogenicity study — Reproduction study — Toxicity research			**(×)**	**(×)**

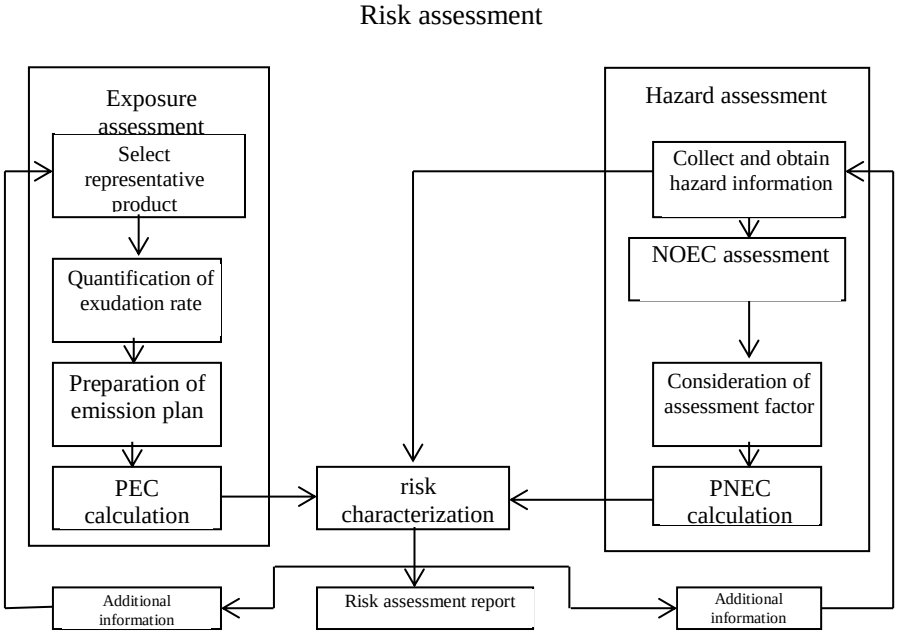
Continued Table 3.3.2

Data item	Required data	Organic matter			Inorganic matter
		Phase 1	Phase 2		
			Step 1	Step 2	
Research on toxicity of second poisoning and metabolism	— Toxicity research — Metabolism study — Medical equipment — Toxic effect on mammalians, including livestock, pet and human			**(×)**	**(×)**
Classification and label	Classification of anti-fouling active substances in GHS Label details (classification, symbol, hazard and precaution statements) on aquatic environment hazard (acute or chronic)	×	×	×	×
Risk characterization	Importance, background concentration, adaptability, bioavailability				**(×)**
	Correction factor and theoretical basis at a suitable place	**(×)**	**(×)**	**(×)**	**(×)**
	Uncertainty, quantization table of these levels*	×	×	×	×
	PEC/PNEC of anti-fouling active substance in environmental medium*	×	×	×	×
	PEC/PNEC of degradation products of anti-fouling active substance			×	×
Risk management	Name of representative anti-fouling product and test result of its toxicity efficiency	**(×)**	**(×)**	**(×)**	**(×)**
Summary		×	×	×	×

Note 1: This table is made on the basis of Appendixes IIA&IIIA, BPD and makes reference to requirements in Appendix 3 of AFS convention.
Note 2: Items marked with * corresponds to Annex 3 of AFS. The items below are included in Annex 3 of AFS, which are not mandatory for environmental risk assessment of anti-fouling active substances according to ISO 13073.
— pH value/dissociation constant
— Oxidation reduction potential
— Mass balance
— Effect of food web/population
— Residual ocean food
GHS: Globally harmonized system of classification and labelling of chemicals
X: Min. data that must be provided
(X): Provide suitable data as demanded

4 Block diagram and steps of environmental risk assessment procedure on the anti-fouling active substances in anti-fouling coating

Environmental risk assessment on the anti-fouling active substances includes three steps: Exposure assessment, hazard assessment, and risk characterization. PEC is produced from the exposure assessment and PNEC from the hazard assessment. Ratio of PEC to PNEC (PEC/PNEC) is a quantitative index of risk assessment, with the assessment procedure block diagram and steps shown in Fig. 3.4. Assessment procedure block diagram and steps are shown in Fig. 1.



Note * If concentration coefficient (BCF) of the organic anti-fouling active substance is more than 2000, accumulation inside the organism is probable, which is deemed as "High Risk To Be Concerned ".

Fig. 3.4 Method of marine environmental risk assessment on the anti-fouling active substances in anti-fouling paint as well as structural block diagram

5 Exposure assessment

Exposure assessment covers analysis on emission way and moving speed of anti-fouling active substances and transformation or degradation products, aiming at assessment of exposure concentration/dose to human population or environmental system, expressed in predicated environmental concentration (PEC).

5.1 Selection basis of representative product: Make assessment based on the most unfavorable conditions.

5.2 Quantitative analysis of leaching rate

Exposure of anti-fouling coating to water environment is mainly caused by penetration of the anti-fouling active substances into the water environment through paint film. Therefore, leaching rate of the anti-fouling active substance is a very important parameter index for environmental risk assessment.

Currently, leaching rate of the anti-fouling active substance is mainly determined via calculation, lab procedure and on-site testing. However, the leaching rate data measured in the tests are highly controversial.

(1) Lab procedure: Based on standard procedures given in ISO, GB and ASTM.

(2) Mass balance method (calculation method): Calculated on the basis of ISO 10890 *Model on Calculation of Leaching Rate of Biocide in Anti-fouling Coating with Mass Balance Method*.

(3) On-site testing method

5.3 Selection of emission mode and calculation

5.3.1 Selection of emission mode

Select the typical marine environment as a representative model (e.g. a typical harbor), with relevant physical, chemical and hydrodynamic parameters used in calculation model of PEC. Parameter setting should take the actual most unfavorable circumstances into consideration.

5.3.2 Setting of relevant parameters on emission scenario

(1) Leaching rate of anti-fouling composition (t ug/ cm^2 d)

(2) Emission parameters on ship anti-fouling composition: Quantity of ships moored and those underway, ratio of ships underway to those moored, and ratio of area of wetted surface of ship (surface areas of ships of various lengths) to area of ship anti-fouling coating.

(3) Scope of target sea area: Length, width (or surface area) and depth of sea area; width and depth of the boundary between target sea area and non-target sea area.

(4) Water quality: Temperature, salinity, pH, silt concentration (silt fraction<63 μm per mg/L), organic carbon fraction [organic carbon volume in sediment (dry mass)], POC and DOC concentrations [concentrations of particulate and dissolved organic carbons, expressed in mg OC/L], and suspended particulate matters in the water column.

(5) Hydrology: Tide exchange speed, flow velocity of river and rivulet connecting the target sea area.

(6) Environmental medium: Depth of mixed sedimentary layer and dissolved organic carbon.

(7) Others.

5.4 Setting of typical PEC parameters

Determine typical PEC parameters in each emission scenario and relevant environmental area according to the marine environmental parameters and relevant parameters for setting emission scenario:

(1) Degradation rate: Biological and abiological degradation (hydrolyzation and photodecomposition) occurring to the anti-fouling active substance in sea water, expressed in the half-life period t.

(2) Particulate matter adsorption rate (or ratio of particles wrapped by the anti-fouling active substance to substances dissolved in sea water).

(3) Organic carbon distribution coefficient (K_{OC}).

(4) Biological concentration coefficient (BCF) of anti-fouling active substances: Ratio of concentration of the anti-fouling active substance in the organism to that of the anti-fouling active substance in the medium.

5.5 Optional mathematic model

The model subject to application verification can be applied: MAMPEC and REMA. Use the selected mathematic model to calculate PEC.

6 Hazard assessment

6.1 Determination of PNEC

6.1.1 Setting of PNEC in sea water (PNECSW)

(1) Use of the chronic toxicity test results to estimate PNECSW

PNECSW is calculated as per the formula below:

$PNEC_{SW}=NOEC_C/AF$

Where:

$PNEC_{SW}$ is the PNEC in sea water (mg/L);

$NOEC_C$ is the lowest non-observed effect concentration measured in the chromic toxicity test, expressed in mg/L.

AF is the assessment factor**.**

(2) Use of the acute toxicity test results to estimate $PNEC_{SW}$

$PNEC_{SW}$ is calculated as per the formula below:

$PNEC_{SW}=L(E)C_{50}/AF$

Where:

$PNEC_{SW}$ is the PNEC in sea water (mg/L);

$L(E)C_{50}$ is the 50% lethal concentration (LC_{50}) or 50% inhibition concentration (EC_{50}) (mg/L);

(3) Anti-fouling active substances with lots of toxicity data

For the anti-fouling active substances with lots of toxicity data, especially heavy metal, probabilistic method can be applied to screen and analyze the toxicity data collected, so as to produce $PNEC_{SW.}$

(4) Statistical extrapolation

The statistical extrapolation is a type of model prediction, which can be referred to in relevant technical guidelines of EC (2003).

6.2.1 Setting of PNEC of organisms in sediments (PNECsed)

(1) Estimation of $PNEC_{sed}$ via the chromic toxicity test data

$PNEC_{sed}$ is calculated as per the formula below:

$PNEC_{sed}=Chronic_{sed}/AF$

$Chronic_{sed}$ is the lowest NOEC obtained from the chromic toxicity test, 10% lethal concentration (LC_{10}) or 10% inhibition concentration ($EC_{10)}$(mg/kg).

(2) Use of the acute toxicity test results to estimate PNECSED

$PNEC_{sed}$ is calculated as per the formula below:

$$PNEC_{sed}=\frac{L(E)C_{50}}{AF}$$

Where:

6.1.3 PNEC setting of birds and mammalians (PNECpred)

PNEC of organisms with higher trophic level than fish is calculated as per the formula below:

$$PNEC_{pred}=\frac{Tox_{pred}}{AF}$$

Where:

Tox_{pred} is the toxicity value of organism with high trophic level, expressed in mg/kg.

6.2 AF (assessment factor)

AF of PNEC based on the test type, quantity of tested species, and trophic level of tested species should be introduced in order to correct the PNEC uncertainty calculated from limited hydrobios.

6.3 Confirmation of PNEC for risk characterization

PNEC for risk characterization is calculated based on the toxicity test data NOEC, $L(E)C_{50}$ and AF, with reliability of calculation results dependent upon NOEC or $L(E)C_{50}$ credibility and rationality of AF.

7 Risk characterization

7.1 Risk characterization process of environmental risk assessment of organic anti-fouling active substances in the ship anti-fouling system

The risk characterization process features various phases and stages. It starts from the first phase

and continues until it goes to stage 2 of phase 2. Besides, the risk characterization is performed in the order of stages 1&2 of phases 1&2 until each anti-fouling active substance can be assessed as "Low Risk", "Lower Risk" or "High Risk To Be Concerned" after the assessment. See Fig. 3.7(1) and Fig. 3.7(2).

At the first phase, three assessment indexes, i.e. biological concentration factor (BCF or BCFp)＜100, degradation half-life period ＜15 days and ratio of PEC/PNEC＜1, are used as the bases of judgment. The anti-fouling active substance can be assessed as low-risk if the above indexes can be reached, implying that it can be used in the anti-fouling coating ingredient; otherwise, go to the second-phase assessment.

For first-phase assessment of phase 2, the organic carbon distribution factor (Koc) should be added, in addition to supplementation and elaboration of the above three indexes. In case of conformity to the requirement, the assessment is passed, implying that the anti-fouling active substance can be used in the anti-fouling coating product within a certain period of time and with a certain quantity. During its application, new data will be added for continuous risk assessment (see Fig. 3.7(2)). In case of nonacceptance, go to the second-phase assessment, during which more data are required to supplement or modify the three indexes at phase 1 (see Fig. 3.7(1)).

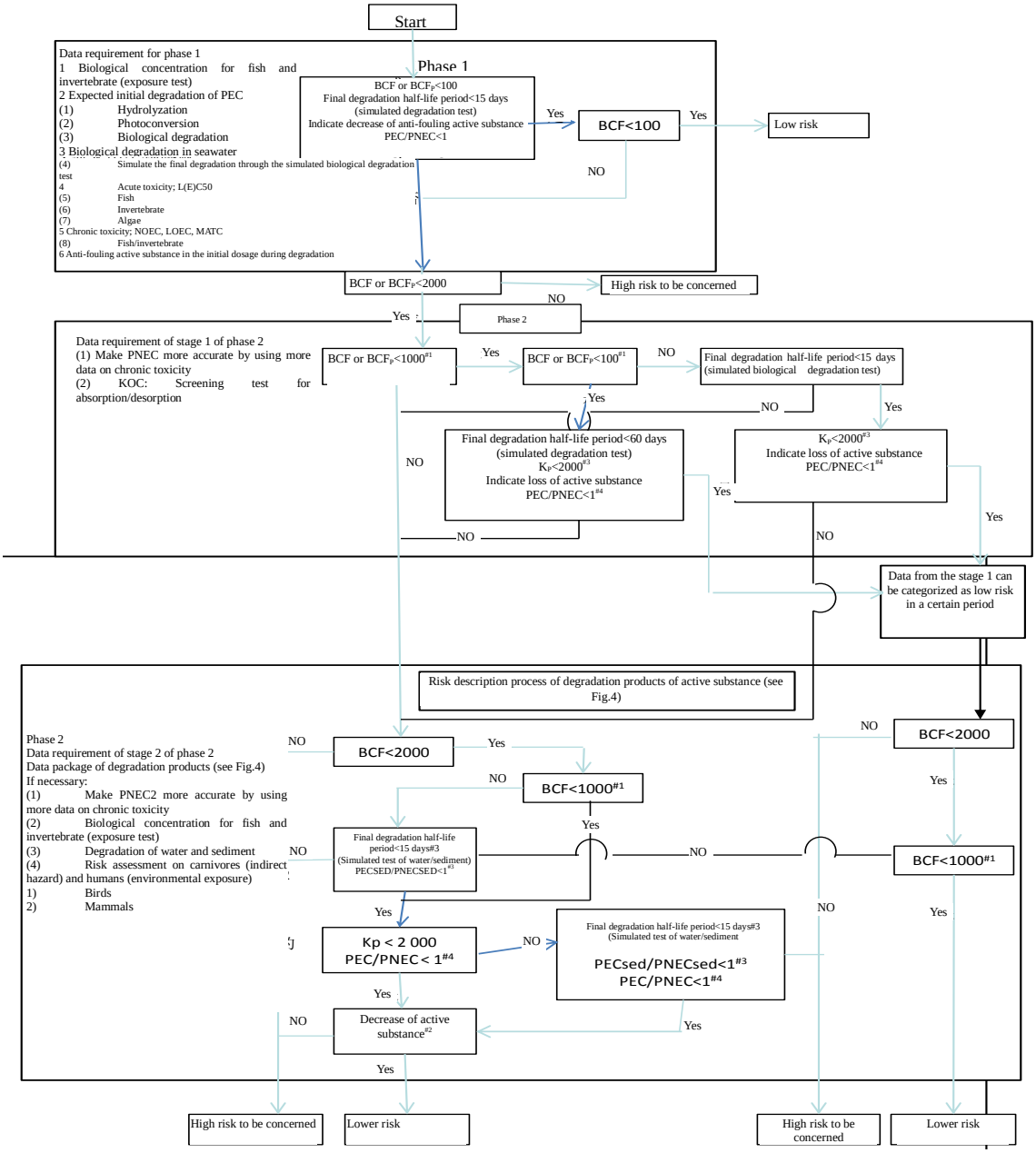
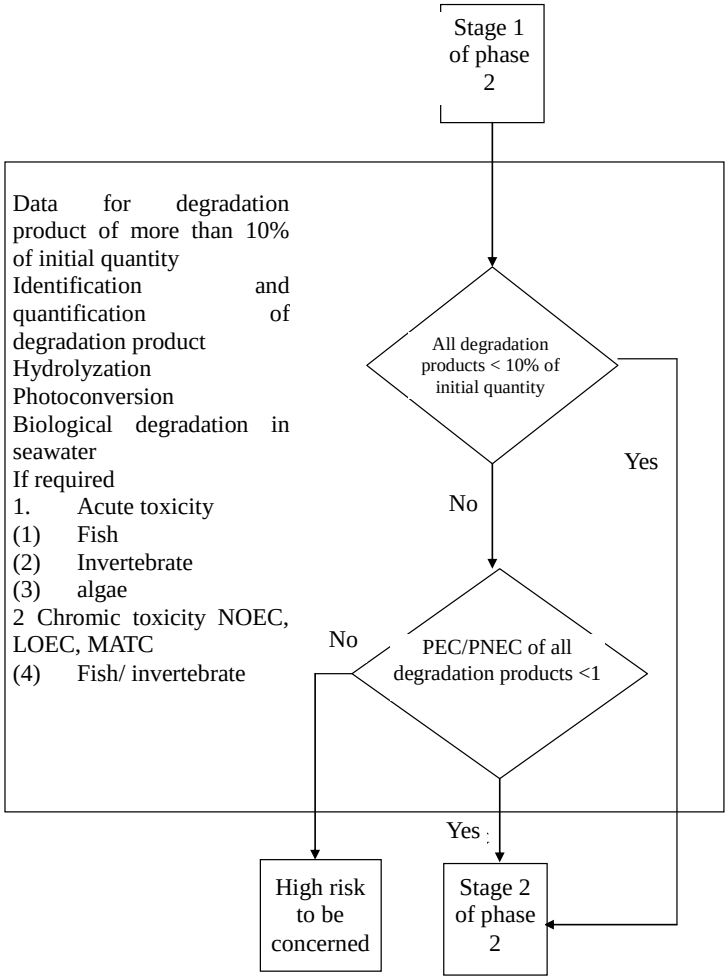


Fig. 3.7(1) Process chart of risk characteristics of organic anti-fouling active substance



Note 1: The PNEC toxicity data on degradation product are obtained from QSAR method.
Note 2: The degradation herein refers to the primary biological degradation. The risk assessment is made based on the fact that the degradation product of main metabolin is 10% higher than the initial dosage of biocide.

Fig. 3.7(2) Process chart of risk characteristics of degradation products of organic anti-fouling active substance

7.2 Risk characteristic assessment of inorganic anti-fouling active substance in anti-fouling system on ships

Since the inorganic anti-fouling active substance cannot be degraded usually and the inorganic substance property and organism interaction mechanism may differ from those of the composite organic substance, the risk assessment adopted may also differ from that of the organic anti-fouling active substance.

A large number of test data on the inorganic substances are available for use; therefore, they should be screened. After that, PEC and PNEC will be calculated via exposure assessment and hazard assessment, which act as the basis for judgment, i.e. lower risk if PEC/PNEC＜1 and high risk if PEC/PNEC＞1. The assessment procedures are shown in Fig. 3.7(3).

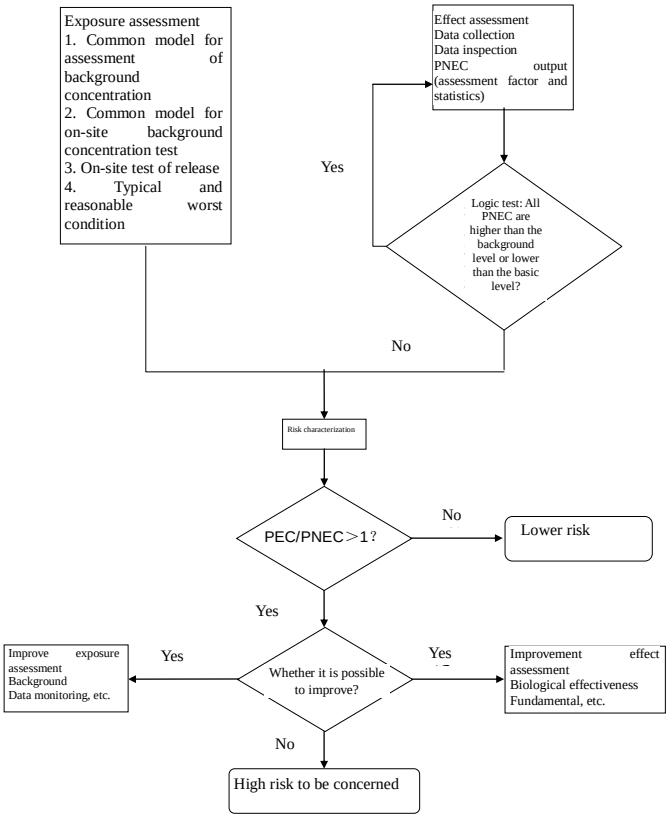


Fig. 3.7(3) Process chart of risk characteristics of inorganic anti-fouling active substance

7.3 Assessment results

The points below include risk characteristics of the anti-fouling active substances applied.

7.3.1 Low risk

If assessed as "Low Risk", the anti-fouling active substance applied in the anti-fouling system on ships poses a negligible risk to the marine environment.

7.3.2 High risk to be concerned

If assessed as "High risk to be concerned", the anti-fouling active substance applied in the anti-fouling system poses a high ecological risk (non-negligible) to the marine environment and triggers concerns as a consequence.

7.3.3 Lower risk

If assessed as "Lower risk", the anti-fouling active substance applied in the anti-fouling system on ships poses a non-negligible risk (but within an acceptable range) to the marine environment.

8 Risk assessment report

8.1 Identification and basic properties of anti-fouling active substances

8.2 Basic properties of anti-fouling paint with the anti-fouling active substance

8.3 Environmental fate and analysis

Environment fate and analysis of the anti-fouling active substance at the actual environmental conditions based on relevant documents, including degradation, accumulation, and effect on environmental organisms (acute and chronic)

8.4 Environmental exposure prediction: Predicated environmental concentration (PEC) in water body and sediment

8.5 Risk characterization: PEC/PNEC in water body and sediment

8.6 Assessment result summary

Whether the anti-fouling active substance in the anti-fouling paint can pass the preliminary marine environmental risk assessment.

To sum up, because the anti-fouling active substance is assessed as "XX risk" if applied in the marine environment, it can (cannot) pass the marine environmental risk assessment.

Appendix 4 List of common anti-fouling active substances in the anti-fouling paint

This annex provides the common anti-fouling active substances in the anti-fouling paint, and the risk assessment is not required temporarily if anti-fouling paints with such substances as the anti-fouling composition are applied for approval at present. However, further evaluation may be required with the technical progress and other discovery in the future. Such list does not mean that those anti-fouling active substances are recommended to be used as the anti-fouling composition of the anti-fouling paint by CCS, and such anti-fouling active substances in Table 4.2 should be used with caution.

List of common anti-fouling active substances in the anti-fouling paint Table 4.1

S/N	Chinese Name	English name	Chinese alias	English alias	CAS No	Main physicochemical properties
1	氧化亚铜	Cuprous oxide	一氧化二铜	Copper hemioxide Copper oxide, red Copper protoxide	1317-39-1	1. Molecular mass (g/mol): 143.09 2. Melting point: 1235 ℃ 3. Boiling point: 1800 ℃ 4. Solubility in water: Insoluble 5. Dissociation constant: No (Kd=131) 6. Distribution coefficient Log KOW: No 7. Distribution coefficient Log KOC: 1235
2	双 (2-巯基吡啶氧化物)铜盐	copper pyrithione	吡啶硫酮铜	Copper pyrithione	14915-37-8	1. Molecular weight (g/mol): 315.86 2. Melting point: 262 ℃ 3. Solubility in water: 0.06 mg/l 4. Distribution coefficient Log KOW: 0.97 5. Distribution coefficient Log KOC: 0.70
3	吡啶硫酮锌	Zinc, bis(1-hydroxy-2(1H)-pyridinethionato-O,S)-, (T-4)-		Zinc pyrithione	13463-41-7	1. Molecular weight (g/mol): 317.68 2. Melting point: 262 3. Solubility in water: 6 mg/l 4. Dissociation constant: 5.9 5. Distribution coefficient Log KOW: 0.97 6. Distribution coefficient Log KOC: 0.7

Continued Table 4.1

S/N	Chinese Name	English name	Chinese alias	English alias	CAS No	Main physicochemical properties
4	4,5-二氯-2-辛基-3(2H)-异噻唑酮	3(2H)-Isothiazolone, 4,5-dichloro-2-octyl-	DCOIT	4,5-Dichloro-2-n-octyl-4-isothiazolin-3-one	64359-81-5	1. Molecular weight (g/mol): 282.07 2. Melting point: 41.1–41.7 ℃ 3. Boiling point: Begin to decompose when the temperature is more than 300 ℃ 4. Vapor pressure: 9.8 x 10-6 hPa 5. Henry constant: 1.334 ×10-8 atm-m3/mol 6. Solubility in water: 14 mg/l 7. Distribution coefficient Log KOW: 2.8 (23 ℃ when pH is 7) 8. Distribution coefficient Log KOC: 2.6
5	2,4,5,6-四氯-1,3-苯二腈	1,3-Benzenedicarbonitrile,2,4,5,6-tetrachloro-	百菌清;四氯间苯二腈	Chlorothalonil Tetrachloroisophthalonitrile	1897-45-6	1. Molecular weight (g/mol): 265.91 2. Melting point: 131.5 ℃ 3. Boiling point: 354.9 ℃ 4. Vapor pressure: 5.7 ×10-7 mmHg 5. Henry constant: 6.35 ×10-9 atm-m3/mol 6. Solubility in water: 0.68 mg/l 7. Distribution coefficient Log KOW: 3.66 (3.05) 8. Distribution coefficient Log KOC: 3.38
6	亚乙基双二硫代氨基甲酸锌	Zinc ethylene-1,2-bis-dithiocarbamate	代森锌	Zinc, [(1,2-ethanediyl bis)(carbamodithioato)](2-)-,Zineb	12122-67-7	1. Molecular weight (g/mol): 275.8 2. Melting point: Begin to decompose before melting (at 157 ℃) 3. Vapor pressure: 9.7 x 10-8 Pa 4. Henry's law constant: 4.68 × 10-7 atm-m3/mol 5. Solubility in water: 10 mg/l 6. Distribution coefficient Log KOW: 0.8 7. Distribution coefficient Log KOC: 0.6
7	硫氰酸亚铜	Cuprous Thiocyanate			1111-67-7	1. Molecular weight (g/mol): 121.63 2. Melting point: 1084 ℃

List of common anti-fouling active substances in the anti-fouling paint Table 4.2

S/N	Chinese Name	English name	Chinese alias	English alias	CAS No	Main physicochemical properties
1	N'-(3,4-二氯苯基)-N,N-二甲基脲	Urea, N'-(3,4-dichlorophenyl)-N,N-dimethyl-	敌草隆;3-(3,4-二氯苯基)-N,N-二甲基脲	Diuron;3-(3,4-Dichlorophenyl)-N,N-dimethyl urea	330-54-1	1. Molecular weight (g/mol): 233 2. Melting point: 159℃ 3. Boiling point: 180℃ 4. Vapor pressure: 0.009 MPa (25℃) 5. Henry's law constant: 5.110-6Pa m3/mol 6. Solubility in water: 42 mg/l 7. Distribution coefficient Log KOW: 2.8 8. Distribution coefficient Log KOC: 2.6
2	吡啶三苯基硼	Pyridine-triphenylborane		TPBP	971-66-4	1. Molecular weight (g/mol): 321.22 2. Melting point: 136 ℃ 3. Boiling point: 347 ℃ 4. Vapor pressure: 1.19 ×10-5 mmHg 5. Henry constant: 1.56 ×10-5 atm-m3/mol 6. Solubility in water: 9.895 × 10-2 mg/L 7. Distribution coefficient Log KOW: 5.52 8. Distribution coefficient Log KOC: 5.65
3	N-(2,4,6-三氯苯)马来酰亚胺	N-(2,4,6-Trichlorophenyl)maleimide		TCPM	13167-25-4	1. Molecular weight (g/mol):276 2. Melting point: 128-131℃ 3. Boiling point: 4. Vapor pressure: 5. Henry constant: 6. Solubility in water: 7. Distribution coefficient Log KOW: 8. Distribution coefficient Log KOC:
4	吡咯腈	Tralopyril(Econea)	4-溴-2-(4-氯苯基)-5-三氟甲基-1H-吡咯-3-甲腈	4-Bromo-2-(4-chlorophenyl)-5-(trifluoromethyl)-1H-pyrrole-3-carbonitrile	122454-29-9	1. Molecular weight (g/mol)：349.53 $g.mol^{-1}$ 2.Melting point: 252.3℃ 3. Vapor pressure:1.9or $^{-8}$ Pa 4. Henry constant:5.4r10^{-8} 5. Solubility in water：0.16 $g.m^{-3}$ 6. Distribution coefficient Log KOW：3.47 7.Distribution coefficient Log KOC：3.66
5	美托咪啶	Medetomidine(Selektope)		(RS)-4-[1-(2,3-dimethylphenyl)ethyl]-1H-imidazole	86347-14-0	1. Molecular weight (g/mol)：200.28 $g.mol^{-1}$ 2. Melting point: 110 – 116℃ 3. Vapor pressure：3.5×10^{-6} Pa 4. Henry constant：8.3 x 10^{-6} 5. Solubility in water：200 $g.m^{-3}$ 6. Distribution coefficient Log KOW：3.1 7.Distribution coefficient Log KOC：3.33

Appendix 5 Test on Simulated Ballast Tank Conditions of Ballast Tanks Paint for Ship

This test is made according to Appendix 1 of IMO MSC.215 (82) Performance Standard of Protective Coatings at Special Seawater Ballast Tanks of All Ships and Both Sides of the Bulk Cargo Ship.

1 Test condition

Test on simulated ballast tank conditions should meet the conditions below:

1.1 The test lasts for 180 days.

1.2 Five test panels are made.

1.3 Each test panel is sized in 200 mm×400 mm×3 mm. U-strips are welded on the two test panels among them (test panels 3&4), with a distance of 120 mm from the short side and 80 mm from the long side.

Fig.1-3: Test panel

The test panel coating system should be selected based on application conditions and planned maintenance of coatings by parties concerned, in addition to requirements in Tables 1.1, 1.2 and 1.3 of IMO MSC.215(82) PSPC; besides, coating of the coating system should be carried out as per 1.4&1.5, Table 1 of IMO MSC.215(82) PSPC. There should be color difference between coatings, and the top coating should be in light color. At least two precoatings and two spray coatings should be applied. One precoating can also be applied to the smooth welding beam provided that it is confirmed that coating thickness after the second coating reaches NDFT. The shop primer should be subject to outdoor aging for at least two months, and then cleaned by low-pressure water or in another gentle way, rather than via sweep-type sandblasting, high-pressure water or other primer removal methods. Attention should be paid to method and degree of outdoor aging, because the primer acts as the basis of 15-year target service life system. In order to encourage innovations, alternative processing method, coating system and dry film thickness are allowed as long as they have been explained clearly.

1.4 Test panel should be coated properly at the back to avoid any effect on test results.

1.5 In order to simulate the actual ballast tank conditions, a cyclic test with natural or artificial seawater loaded for two weeks and no load for one week will be performed. The seawater temperature should be kept at about 35℃.

1.6 Test panel 1: The test panel should be heated for 12 h at 50℃ and then cooled for 12 h at 20℃, so as to simulate the upper deck conditions. The test panel should be subject to periodical natural/artificial seawater splashing so as to simulate pitching and rolling of ships, with a splashing interval of 3 s or less. Scribed lines should extend across the test panel width and

downwards into the substrate.

1.7 Test panel 2: One zinc sacrificial anode should be installed on the test panel to evaluate the cathodic protection efficiency. Round artificial leakage holes of 8 mm in diameter with exposed substrates should be provided on the test panel 100 mm away from the anode, so as to evaluate the cathodic protection efficiency. The test panel is immersed in the seawater in a cyclic manner.

1.8 Test panel 3: The test panel should be subject to cooling at the back to form a temperature gradient of about 20℃ so as to simulate cooling bulkhead of a topside ballast tank; besides, the natural or artificial seawater splashing should be performed to simulate pitching and rolling of ships, with a splashing interval of 3 s or less. Scribed lines should extend across the test panel width and downwards into the substrate.

1.9 Test panel 4: The test panel should be subject to natural or artificial seawater splashing to simulate pitching and rolling of ships, with a splashing interval of 3 s or less. Besides, scribed lines should extend across the test panel width and downwards into the substrate.

1.10 Test panel 5: The test panel should be exposed for 180 days at 70℃ in dry conditions, so as to simulate bulkhead between the double-deck bottom heating fuel tank and ballast water tank.

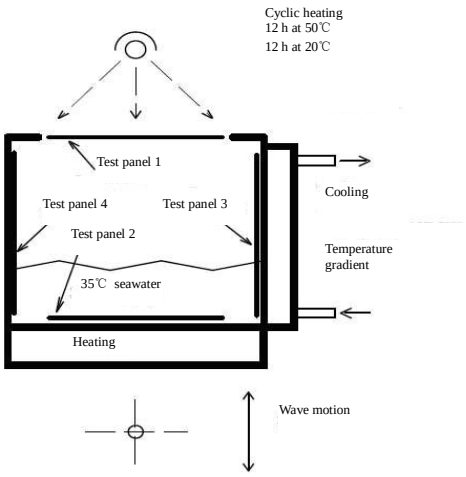


Fig. 1 Wave tank for ballast tank coating test

2 Test result

2.1 Prior to test, report the following measuring data on the coating system:

(1) Infrared identification of base stock and curing agent components of the coating

(2) Proportion of base stock and curing agent components of the coating: Refer to ISO2811-4 Pigmented Paint and Varnish - Density Measurement.

(3 Pinhole quantity: Measure it via a 90 V low-voltage detector.

2.2 Report the following measurement data after testing:

(1) Blistering and rustiness: Refer to ISO 4628-2 Pigmented Paint and Varnish - Assessment of Coating Aging - Assessment of Quantity, Size and Uniform Change Degree in Appearance

for Defects: Part 2 - ISO 4628-3 Pigmented Paint and Varnish - Assessment of Coating Damage - Assessment of Quantity and Size of Common Defects - Part 3: Assessment of Rustiness Grade.

(2) Thickness of dry film (DFT) (use template): 9 measuring points are distributed uniformly on the template of 150 mm×150 mm; 15 measuring points are distributed uniformly on the template of 200 mm×400 mm.

(3) Adhesive force: Refer to ISO4624 Pigmented Paint and Varnish - Pull-off Test for Adhesion.

(4) Flexibility after adjustment as per panel thickness: Refer to ASTM D4145 Standard Test Method for Coating Flexibility of Prepainted Steel Sheet. 3 mm panel, 300 μm coating, 150 mm cylindrical shaft, and elongation rate of 2% are only available for reference.

(5) Weight loss of cathodic protection/demanded current/peeling-off at the artificial leakage.

(6) Spread of corrosion near the scratch. Measure spread of corrosion of each test panel along both sides of the scratch and determine the max. spread of corrosion, and then take the average value of three max. values as the acceptance value.

3 Acceptance standard

3.1 Test results of Section 2 should meet the following standards:

Result Requirements for Test on Simulated Ballast Tank Conditions of Ballast Tanks Paint for Ship Table 5.3.1

Item	Acceptance standard for epoxy group system coated according to Table 1 of PSPC	Acceptance standard of alternative system
Test panel blistering	No blistering	No blistering
Test panel rusting	Ri0 level (0%)	Ri0 level (0%)
Pinhole quantity	0	0
Adhesive force	＞3.5 MPa, separation area between base stock and coating as well as between coatings is 60% or more.	＞5.0 MPa, separation area between base stock and coating as well as between coatings is 60% or more.
Cohesion	＞3.0 MPa Cohesional failure area in the coating is 40% or more	＞5.0 MPa Cohesional failure area in the coating is 40% or more
Current required for cathodic protection that is calculated as per weight loss	＜5 mA/m^2	＜5 mA/ m^2
Cathodic protection; peeling-off at the artificial leakage	＜8 mm	＜5 mm
Spread of corrosion near the scratch	＜8 mm	＜5 mm
U-strip	In case of defect, crack or peeling-off at the corner or weld seam, the system is unacceptable.	In case of defect, crack or peeling-off at the corner or weld seam, the system is unacceptable.

3.2 The tested epoxy group system coated according to Table 1 of PSPC should meet the

requirement in the above table for the epoxy group system.

3.3 The possible alternative system of epoxy group system and/or the alternative system not necessarily coated according to Table 1 of PSPC should meet the requirement in the above table for the alternative system.

4 Test report

Test report should include the following:

4.1 Name of manufacturer

4.2 Test date

4.3 Name/identification of coating and primer

4.4 Batch No.

4.5 Surface treatment data of steel plate, including:

(1) Mode of surface treatment

(2) Content of water soluble salt

(3) Dust

(4) Abrasive inserts

4.6 Coating data of coating system include the following (coating interval, dry film thickness prior to test, thinner, humidity and temperature include the actual sample data and demanded/recommended values of manufacturer)

(1) Shop primer

(2) Quantity of coating layers

(3) Coating interval

(4) Dry film thickness prior to test

(5) Thinner

(6) Humidity

(7) Temperature

(8) Steel plate temperature

4.7 Test results based on Section 2; and

4.8 Results measured as per Section 3.

Appendix 6 Condensation chamber test on ballast tanks paint for ship

This test is made according to Appendix 2 of IMO MSC.215 (82) Performance Standard of Protective Coatings at Special Seawater Ballast Tanks of All Ships and Both Sides of the Bulk Cargo Ship.

1 Test condition

The condensation chamber test is performed as per appropriate standard, namely, ISO6270-1 Pigmented Paint and Varnish - Determination of Resistance to Humidity - Part 1: Continuous Condensation.

1.1 Exposure lasts for 180 days.

1.2 Two test panels are required.

1.3 Each test panel is sized in 150 mm×150 mm×3 mm. Test panel should be processed as per Articles 1, 2 and 3, Table 1, IMO MSC.215(82) PSPC Performance Standard. Coating system should be coated as per 1.4 & 1.5, Table 1, IMO MSC.215 (82) PSPC. The shop primer should be subject to outdoor aging for at least two months, and then cleaned by low-pressure water or in another gentle way, rather than via sweep-type injection, high-pressure water or primer removal methods. Attention should be paid to method and degree of outdoor aging, because the primer acts as the basis of 15-year target service life system. In order to encourage innovations, alternative processing method, coating system and dry film thickness are allowed as long as they have been explained clearly.

1.4 Test panel should be coated properly at the back to avoid any effect on test results.

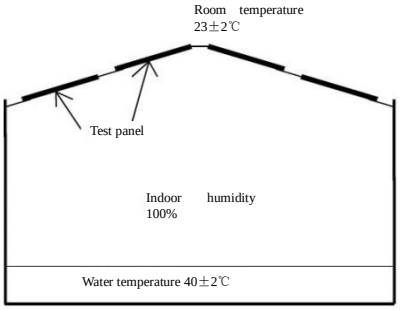


Fig. 2 Condensation chamber test

2 Test result

According to Section 2 of Annex 3, spread of corrosion near the scratch and weight loss of cathodic protection/demanded current/peeling-off at the artificial leakage are excluded.

3 Acceptance standard

3.1 Test results based on Section 2 should meet the following standards:

Result Requirements for condensation chamber test on ballast tanks paint for ship
Table 6.3.1

Item	Acceptance standard for epoxy group system coated according to Table 1 of PSPC	Acceptance standard of alternative system
Test panel blistering	No blistering	No blistering
Test panel rusting	Ri0 level (0%)	Ri0 level (0%)
Pinhole quantity	0	0
Adhesive force	＞3.5 MPa, separation area between base stock and coating as well as between coatings is 60% or more.	＞5.0 MPa, separation area between base stock and coating as well as between coatings is 60% or more.
Cohesion	＞3.0 MPa Cohesional failure area in the coating is 40% or more	＞5.0 MPa Cohesional failure area in the coating is 40% or more

3.2 The tested epoxy group system when coated according to Table 1 of IMO MSC.215(82) PSPC should meet the requirement in the above table for the epoxy group system.

3.3 The possible alternative system of epoxy group system and/or the alternative system not necessarily coated according to Table 1 of PSPC should meet the requirement in the above table for the alternative system.

4 Test report

According to Section 4 of Annex 5.

Appendix 7 Gas-tight chamber test simulating the vapor phase of the loaded cargo tank

This test is made according to Annex 1 of IMO MSC.288 (87) Performance Standard of Protective Coating for Cargo Oil Tank of the Crude Oil Tanker.

1 Test condition

The vapor test should be performed in the gas-tight chamber. There will be no mandatory requirement for size and design of the gas-tight chamber as long as requirements given in 1.6-1.10 below have been met. The test gas should be provided such that it can simulate the actual environment inside the crude oil tank in ballasted condition and the vapor condition during loading of the crude oil tank.

1.1 Exposure lasts for 90 days.

1.2 Use two same templates for test; prepare the third template and store it in the ambient environment as the reference template for final assessment on the test panel.

1.3 Each test panel is sized in 150 mm×100 mm×3 mm.

1.4 Test panel should be processed according to requirements given in 1.2, Table 1, IMO MSC.288 (87) Performance Standard. Coating system should be coated according to 1.4&1.5, Table 1, IMO MSC.288 (87) Performance Standard.

1.5 The zinc silicate shop primer, if used, should be subject to outdoor aging for at least two months and cleaning via low-pressure fresh water. A report on true processing method of shop primer prior to coating should be issued, together with a written decision on the system. In order to avoid effect on test results, the test panel should be coated properly at the back and edges.

1.6 One water trough should be provided in the gas-tight chamber. The water trough should be filled with 2±0.2 L water. The water trough should be emptied and filled with fresh water always prior to charging of fresh test gas.

1.7 The vapor layer in the gas-tight chamber should be filled with mixture of test gases according to requirements given in 5, Appendix 1, IMO MSC.288 (87) Performance Standard. The air inside the tank should be kept stable during testing. However, change is required if the gas is beyond the scope of test method. Monitoring frequency and method as well as date and time of changing test gas should be recorded in the test report.

1.8 The air inside the tested gas-tight chamber should be kept at a relative humidity of 95±5% all the time.

1.9 The air to be tested should be kept at 60±3℃.

1.10 One test panel support made of suitable inert materials should be provided to support the test panel vertically, with a distance of at least 20 mm between test panels. The test panel support should be located in the gas-tight chamber such that the bottom edge of the test panel is at least 200 mm from water level and at least 100 mm from the tank wall. In case of two layers of supports inside the gas-tight chamber, always ensure that the solution will not drop down onto the test panel at the lower layer.

2 Test result

2.1 Prior to testing, the following measuring data on each layer of coating of the coating system should be reported, including those on zinc silicate shop primer (if used in the coating system).

2.1.1 Infrared identification of base stock and curing agent components of the coating.

2.1.2 Proportion of base stock and curing agent components of the coating; and

2.1.3 Average dry film thickness (DFT) (use template)

2.2 After testing, take the test panel out of the gas-tight chamber and then clean it with warm running water. Use the absorbent paper to dry the test panel completely and make assessment on rustiness and blistering of the test panel within 24 h after testing.

2.3 Report the following measurement data after testing: Blistering and rustiness.

3 Acceptance standard

3.1 Test results based on Section 2 should meet the following standards and the report should cover the test results of two test panels, whichever is lower:

Acceptance standard **Table 7.3.1**

Item	Acceptance standard of epoxy group system	Acceptance standard of alternative system
Test panel blistering	No	No
Test panel rusting	Ri0 level (0%)	Ri0 level (0%)

3.2 The blistering or rustiness within 5 mm of the test panel edge should be negligible during assessment of the test panel.

4 Test report

Test report should include the following:

4.1 Name and manufacturing location of the coating manufacturer.

4.2 Test date

4.3 Name/identification of each layer of coating and zinc silicate shop primer (if applicable).

4.4 Batch No. of each component of products.

4.5 Details of steel plate surface treatment prior to coating of shop primer and the shop primer treatment prior to paint coating (if applicable) should include the following at least:

4.5.1 Surface treatment, shop primer processing after outdoor aging, and other important processing information associated with performance; and

4.5.2 Level of water soluble salt measured on steel plate prior to coating of shop primer

4.6 Details of coating system include the following:

4.6.1 Second surface preprocessing and coating conditions and the outdoor aging time of zinc silicate shop primer (if applicable).

4.6.2 Quantity of coating layers, including shop primer and thickness of each layer.

4.6.3 Average dry film thickness (DFT) prior to testing

4.6.4 Thinner (if used)

4.6.5 Humidity

4.6.6 Temperature; and

4.6.7 Steel plate temperature

4.7 Detailed timetable of change of test gas

4.8 Test results based on Section 2; and

4.9 Results measured as per Section 3.

Appendix 8 Immersion test simulating the loaded condition of the crude oil tank

This test is made according to Annex 2 of IMO MSC.288 (87) Performance Standard of Protective Coating for Cargo Oil Tank of the Crude Oil Tanker.

1 Test condition

The immersion test is designed to simulate the loaded condition of the crude oil tanks.

1.1 Exposure lasts for 180 days.

1.2 Allocate the test liquid according to requirements given in 1.6, Annex 5 of this Guideline.

1.3 Add the test liquid to a container with flat inner bottom until it rises up to 400 mm to get the aqueous phase of 20 mm. It is also acceptable that other test plan is carried out to keep the test panel immersed in the aqueous phase of 20 mm as long as the same test liquid is applied. For example, the inert marble can be used for the purpose.

1.4 The test liquid should be at 60±2℃. Therefore, the approved method should be applied to keep this temperature uniform and unchanged, e.g. water bath, oil bath or hot air circulation oven capable of maintaining the immersion liquid within the required temperature range.

1.5 During testing, the test panel should be located vertically and immersed completely.

1.6 Use two same test panels for test.

1.7 Use the inert separation device that does not cover the test area to separate the test panel.

1.8 Each test panel is sized in 150 mm×100 mm×3 mm.

1.9 Test panel should be processed according to requirements given in 1.2, Table 1, IMO MSC.288 (87) Performance Standard. Coating system should be coated according to 1.4&1.5, Table 1, IMO MSC.288 (87) Performance Standard.

1.10 The zinc silicate shop primer, if used, should be subject to outdoor aging for at least two months and cleaning via low-pressure fresh water. A report on true processing method of shop primer prior to coating should be issued, together with a written decision on the system. In order to avoid effect on test results, the test panel should be coated properly at the back and edges.

1.11 After the complete immersion test, remove the test panel from the test liquid and use the clean dry cloth to dry it before assessment.

1.12 Perform the assessment on the test panel within 24 h after the test.

2 Test result

2.1 Prior to testing, the following measuring data on each layer of coating of the coating system should be reported, including those on zinc silicate shop primer (if used in the coating system).

2.1.1 Infrared identification of base stock and curing agent components of the coating.

2.1.2 Proportion of base stock and curing agent components of the coating; and

2.1.3 Average dry film thickness (DFT) (use template)

2.2 Report the following measurement data after testing: Blistering and rustiness.

3 Acceptance standard

3.1 Test results based on Section 2 should meet the following standards and the report should cover the test results of two test panels, whichever is lower:

Acceptance standard **Table 8.3.1**

Item	Acceptance standard of epoxy group system	Acceptance standard of alternative system
Test panel blistering	No	No
Test panel rusting	Ri0 level (0%)	Ri0 level (0%)

3.2 The blistering or rustiness within 5 mm of the test panel edge should be negligible during assessment of the test panel.

4 Test report

Test report should include the following:

4.1 Name and manufacturing location of the coating manufacturer.

4.2 Test date

4.3 Name/identification of each layer of coating and zinc silicate shop primer (if applicable).

4.4 Batch No. of each component of products.

4.5 Details of steel plate surface treatment prior to coating of shop primer and the shop primer treatment prior to paint coating (if applicable) should include the following at least:

4.5.1 Surface treatment, shop primer processing after outdoor aging, and other important processing information associated with performance; and

4.5.2 Level of water soluble salt measured on steel plate prior to coating of shop primer

4.6 Details of coating system include the following:

4.6.1 Second surface preprocessing and coating conditions and the outdoor aging time of zinc silicate shop primer (if applicable).

4.6.2 Quantity of coating layers, including shop primer and thickness of each layer.

4.6.3 Average dry film thickness (DFT) prior to testing

4.6.4 Thinner (if used)

4.6.5 Humidity

4.6.6 Temperature; and

4.6.7 Steel plate temperature

4.7 Test results based on Section 2; and

4.8 Results measured as per Section 3.