GUIDANCE NOTES
GD 03-2009

CHINA CLASSIFICATION SOCIETY

GUIDELINES FOR ANTICORROSION INSPECTION OF HULL STRUCTURE

2009

Effective from July 1 2009

Beijing

CONTENTS

CHAPTER 1 GENERAL

1.1 Purpose

1.1.1 The Guidelines for Anticorrosion Inspection of Hull Structure (hereinafter referred to as "the Guidelines") are developed in order to effectively control the corrosion of steel structure for ships, extend the service life of structures, and prevent structural failure caused by undue anticorrosion measures.

1.1.2 The purpose of the Guidelines is to provide guidance for anticorrosive design, construction and inspection of ship's steel structures.

1.1.3 The Guidelines provide operational guidance to the flag State Governments with regard to mandatory implementation of, or to the owners with regard to voluntary request for implementation of IMO technical requirements related to the protective coatings for specific spaces of ships.

1.2 Application

1.2.1 The Guidelines apply to the concerned design, construction and inspection of the coating application, sacrificial anodic protection, impressed current protection for ship's steel structures required by the CCS Rules and/or entrusted.

1.2.2 The Guidelines are also references for steel structural anticorrosion of offshore installations, marine products and other industrial products.

1.3 Definitions

1.3.1 For the purpose of the Guidelines:

(1) Coating application means a process of applying paint on substrate surface to form a protective, decorative or especially functional coating.

(2) Ground means the surface of base material with or without coat.

(3) Dew point is the temperature at which air is saturated with moisture.

(4) Primary surface preparation means a technological process to remove scale, rust and obstructions from steel plates or sections by mechanical or chemical method and apply shop-primer prior to construction.

(5) Secondary surface preparation means a technological process of surface retreatment for the surface with shop-primer (or other coating) where rust appears again due to damage of original coating caused by heat influence or mechanical damage.

(6) Dust is loose particle matter present on a surface prepared for painting, arising from blast-cleaning or other surface preparation processes, or resulting from the action of the environment.

(7) Blast cleaning means a technological process to clean and rough the ground surface by the impacting action of high speed abrasive.

(8) Power tool grinding means a technological process to remove rust and obstructions from ground surface by power tool.

(9) Nominal dry film thickness (NDFT) means the nominal thickness of the coating after drying or curing to form the film as specified by design.

(10) Shop-primer is the prefabrication primer coating applied to steel plates, often in automatic plants, in order to protect the surface of metallic material during fabrication.

(11) Primer coat is the first coat of the coating system applied after shop-primer application.

(12) Hard coating is a coating that chemically converts during its curing process or a non-convertible air drying coating which may be used for maintenance purposes. It can be either inorganic or organic.

(13) Stripe coating is painting of edges, welds, hard to reach areas, etc., to ensure good paint adhesion and proper paint thickness in critical areas.

(14) Target useful life is the target value, in years, of the durability for which the coating system is designed.

(15) Coating Technical File (CTF) means a term used for the collection of documents describing issues related to the coating system and its application and maintenance and repair including the job specifications, record of coating work and inspection report demonstrating the quality and performance of coating for the entire life of the ship.

(16) Technical Data Sheet (TDS) is paint manufacturers' Product Data Sheet which contains detailed technical instruction and information relevant to the coating and its application.

(17) Coating specification means the specification of coating systems which includes the type of coating system, steel preparation, surface preparation, surface cleanliness, environmental conditions, application procedure, acceptance criteria and inspection.

(18) Material Safety Data Sheet (MSDS) contains information on safety, health and environmental protection related to chemical substances and products, as well as data regarding basic knowledge, protective measures and emergency actions related to chemicals.

(19) Cathodic protection means a protective method to reduce corrosive potential of the protected metal by electrochemical method and make it to be the cathode in corrosive batteries and obtain anticorrosion effect.

(20) PSPC is the abbreviation of Performance Standard for Protective Coatings, and the class notation for protective coatings applied in specific spaces of ships.

(21) Anode means an electrode through which direct current passes into electrolyte in the corrosive batteries.

(22) Sacrificial anode means an electrode to protect its coupled cathode depending on current of its own corrosion.

(23) Impressed current cathodic protection means the cathodic protection where protective current is supplied by external electrical source.

(24) Protective current density means a necessary polarization current density for the potential of protected object to be maintained within the protective potential ranges.

(25) Protective potential range means an interval of polarization potential values for the metallic corrosive rate to meet the determined protection requirements.

1.4 Class notation

1.4.1 The coating system applied in accordance with the relevant requirements of the Guidelines, upon the request of the shipowner, may be assigned with the following notations respectively for the spaces to be coated after satisfactory survey:

(1) dedicated seawater ballast tanks PSPC(B);

(2) double-side skin spaces of bulk carriers PSPC(D);

(3) cargo oil tank spaces of crude oil tankers PSPC(C);

(4) void spaces of ships PSPC(V).

1.4.2 For ships with the coating application notation, the annual, intermediate and special surveys are to be carried out for the coating in specific spaces related to the notation, in accordance with CCS requirements for survey of different ship types during operation of a ship. The coating is to be maintained in not less than "FAIR" condition as specified in Chapter 8 of the Guidelines. In addition, relevant documents are to be checked in order to verify the good maintenance of coating in the special survey. Where a coating has been repaired, relevant records showing that the repair has been carried out in accordance with coating technical file on board are to be available.

1.4.3 Where a coating is found in "POOR" condition during survey, it is to be repaired in a timely manner, otherwise the class notation for relevant space is to be withdrawn.

CHAPTER 2 ANTICORROSIVE DESIGN, CONSTRUCTION AND INSPECTION UNITS AND PERSONNEL

2.1 General requirements

2.1.1 The independent third-party units engaged in ship's steel structural anticorrosive design, construction or coating inspection are to be qualified in accordance with the requirements of this Chapter.

2.1.2 The personnel engaged in coating inspection of steel structures are to be in compliance with the relevant requirements of this Chapter.

2.2 General procedures for unit approval

2.2.1 The units intended to obtain the approval of the ship's structural anticorrosive design, construction or survey from CCS are to submit an application and the following documents:

(1) name and address of the unit (note to be added in case of a department of the unit);

(2) qualification of the unit;

(3) items to be approved;

(4) total number of the personnel and the number, experience and qualification of the related technicians;

(5) the relevant information meeting the requirements of 2.3 in this Chapter.

2.2.2 CCS will verify, after receiving an application, the actual ability of the unit in accordance with the content of the application. The unit can be engaged in the steel structural anticorrosive design and/or construction in compliance with the content of certificate only after it is approved by and obtains the certificate from CCS.

2.3 Unit and personnel engaged in anticorrosive design

2.3.1 The unit engaged in steel structural anticorrosive design is to meet at least the following basic conditions of:

(1) at least two technicians capable of designing anticorrosive system and guiding anticorrosive construction;

(2) a complete set of quality management system (e.g. ISO 9000 System Certification);

(3) a whole set of design equipment (software and hardware);

(4) at least one set of design information (case) in compliance with the content of application and for practicable use.

2.3.2 The personnel intended to be engaged in steel structural anticorrosive design are to meet at least the following basic conditions of:

(1) graduation from colleges or universities and specially trained;

(2) having the experience and capabilities of metal corrosion and steel structural anticorrosive design;

(3) mastering the structural corrosion characteristics and anticorrosion requirements;

(4) being familiar with the relevant rules and standards.

2.4 Unit and personnel engaged in anticorrosive construction

2.4.1 The unit engaged in steel structural anticorrosive construction is to meet at least the following basic conditions of:

(1) at least two technicians capable of guiding and supervising the structural anticorrosive construction and at least two well-trained quality inspectors;

(2) a complete set of quality management system (e.g. ISO 9000 System Certification) and a complete system of safety production management;

(3) all equipment meeting the construction demands (including leased equipment);

(4) all instruments necessary for the construction quality inspection.

2.4.2 The personnel intended to be engaged in management of steel structural anticorrosive construction are to meet the following basic conditions of:

(1) being rich in experience of anticorrosive construction and being capable of organizing construction in accordance with the technological requirements;

(2) mastering technological standards, understanding technological specifications of construction correctly and being capable of guiding the producing operation;

(3) aving been trained on safety, mastering the key points of safety operation and having experience of safety production management on site.

2.5 Unit and personnel engaged in coating inspection

2.5.1 The unit engaged in coating inspection is to meet at least the following basic conditions of:

(1) at least two coating inspectors with qualifications as verified by CCS (e.g. CCMCIC-II, NACE-II, FROSIO-III or an equivalent qualification);

(2) a complete set of quality management system (e.g. ISO 9000 System Certification) and a complete system of coating inspection management;

(3) all instruments and equipment meeting the inspection demands (including leased equipment).

2.5.2 Coating inspectors required to carry out inspections and issue inspection reports are to be qualified to Coating Inspector Qualification Level II or above as verified by CCS.

2.5.3 Coating inspectors with at least 2 years relevant coating inspector experience and qualified to Coating Inspector Qualification Level II or above as verified by CCS, can write and/or authorize procedures, or decide upon corrective actions to overcome non-compliances.

2.5.4 Assistant inspectors assisting the coating inspector are to meet the following requirements:

(1) they are to be trained by the inspector, the yard's or the coating manufacturer's training organisation or inspection equipment manufacturer to confirm competence in using the measuring equipment, the capability of surface preparation and coating quality judgment, and confirm knowledge of the measurements as required;

(2) such training is to be recorded and endorsed either by the inspector or the training organisation. Relevant training and working are to be recorded to the coating inspector's satisfaction;

(3) assistant inspectors are to do the part of the inspections under the coating inspector's supervision.

CHAPTER 3 PAINTS

3.1 General requirements

3.1.1 The requirements of this Chapter apply to the selection of paint used for coating protection of ships and offshore installations in different cases.

3.1.2 The paint used for ships and offshore installations is to be suitable for ocean corrosive environment. The coating manufacturer is to be subject to works approval by CCS (the approval requirements for paint are referred to in Chapter 1, PART FOUR of CCS Guidelines for Survey of Marine Products).

3.1.3 Coating manufacturers are to have products with documented satisfactory performance records and technical data sheets. The manufacturers are also to be capable of rendering adequate technical assistance.

3.1.4 Each paint product is to be furnished with Material Safety Data Sheet (MSDS).

3.2 General requirements for paint

3.2.1 The paint is to have good adhesion between coating and ground and between the coatings, not less than 3 MPa in general. For primer coat applied to the zinc coating, the adhesion value is not to be less than 1 MPa in general.

3.2.2 Paint with a flammable nature (e.g. nitrocellulose paint) after drying of the coating is not to be applied in ships and offshore installations.

3.2.3 For oil tankers, paint containing aluminum is not to be used in positions where cargo vapours may accumulate unless it has been shown by appropriate tests that the paint to be used does not increase the incendiary sparking hazard. Tests need not be performed for coatings with less than 10 percent aluminum by weight.

3.2.4 Paint containing lead (e.g. red lead) and polluting dissolvent such as benzene and glycol ether is to be avoided in so far as practicable.

3.2.5 Paint with lower content of VOC is to be used in so far as practicable. Paint with thick film, less dissolvent or without dissolvent is recommended.

3.2.6 The minimum value of total dry film thickness and the maximum value of each coating are to be determined according to the value recommended by the coating manufacturer.

3.3 Shop-primer

3.3.1 The composition of the shop-primer is to be such that it will not affect the quality of welds and have no significant deleterious effect on subsequent welding work.

3.3.2 The shop-primer is to be compatible with the paints or other coatings subsequently applied in association with an approved system of corrosion control for structures.

3.3.3 The shop-primer thickness is to be in compliance with the recommended value in the product specifications supplied by the manufacturer; in general, for shop-primer containing zinc, 15～20μm and for shop-primer not containing zinc, 20～25μm. Any special requirement is to comply with product specifications supplied by the manufacturer. During the coating application, the shop-primer thickness is not to exceed twice the recommended value.

3.4 Rust-resisting paint under waterline

3.4.1 The rust-resisting paint used for ships' and offshore installations' positions exposing in the seawater (areas under waterline) is to have good seawater resistance, and no flaking or breakdown appears under permanent submersing in the seawater.

3.4.2 The rust-resisting paint under waterline is to be of a non-saponifiable type and to be suitable for cathodic protection measures. No flaking or breakdown of the coating film is to appear under the permanent condition corresponding to ≥-1.10V potential of $Cu/CuSO_4$ reference electrode.

3.4.3 The film thickness of rust-resisting paint under waterline is to be determined according to the value recommended by the manufacturer and in accordance with the requirements of designed anticorrosion life. The anticorrosion life of coating is to be at least more than three years.

3.5 Antifouling paint

3.5.1 The antifouling paint used under ships' and offshore installations' waterline is to restrain the adhesion of marine organisms. Where the antifouling paint is aging or damaged, good adhesion between the antifouling paint for recoating or repairing and the original coating is to be kept.

3.5.2 The film thickness of antifouling paint is to be determined according to the value recommended by the coating manufacturer and in conjunction with the period of docking surveys.

3.5.3 The anti-fouling agent used in the antifouling paint is not to pose excessively and potentially harmful impact on non-target organisms and human health. The use of organotin compounds and DDT which act as anti-fouling agent is prohibited.

3.6 Ballast tank paint

3.6.1 The paint used for ballast tanks is to have good seawater resistance and wet/dry alternative properties. Coatings for application underneath sun-heated decks or on bulkheads forming boundaries of heated spaces are to be able to withstand repeated heating and/or cooling without becoming brittle.

3.6.2 The ballast tank paint is to be of a non-saponifiable type and suitable for sacrificial anodic protection.

3.6.3 The ballast tank paint is suitable for two or more-layer coating application and each coating is to have a different color with the surface being in light color. No tar (asphalt) paint is to be applied.

3.6.4 The coating system of ballast tanks is in general to be epoxy-based system, with the film thickness not less than 320 μm. Other systems, if used, are to be in accordance with the design requirements, as recommended by the manufacturer and verified by tests.

3.6.5 The coating system of ballast tanks is to have a target useful life of 15 years.

3.6.6 The shop primer used in combination with the main coating of ballast tanks is subject to a pre-qualification test. Sa 2 is to be achieved by removing at least 70% of intact shop primer, which has not passed a pre-qualification test.

3.7 Drinking fresh water tank paint

3.7.1 The paint used for drinking fresh water tanks is to have good water resistance and workmanship.

3.7.2 The drinking fresh water tank paint is not to affect the quality of the loaded drinking fresh water. Paint with less dissolvent or without dissolvent is to be applied.

3.8 Cargo hold paint

3.8.1 The paint used for cargo holds in bulk carriers (including ore/bulk/oil carriers) is to have good toughness and wearability; the paint used for cargo holds with cargo/seawater alternate loading is also to have good seawater resistance.

3.8.2 The paint used for cargo holds loaded with grains is not to pollute the grains.

3.8.3 Where cargo holds are loaded with dangerous goods, the coating manufacturer is to provide technical guidance.

3.9 Internal compartment finish paint

3.9.1 The internal compartment finish paint means that coated in the interior of engine rooms and superstructures, and its primer coat is to have good antirust properties and good adhesion with the ground; the finish paint is to have good decorating properties.

3.9.2 The internal compartment finish paint is to have low flame-spread properties after forming of dry film, and no excessive smoke or other noxious substances is to appear in the case of fire.

3.10 Anodic shield paint

3.10.1 The assembly and complement of the anodic shield paint are to be supplied by the manufacturer.

3.10.2 The anodic shield paint is to have good resistance to corrosion and potential.

CHAPTER 4 GENERAL REQUIREMENTS FOR PROTECTIVE COATINGS OF HULL STRUCTURE

4.1 Application

4.1.1 This Chapter specifies general requirements for surface preparation and coating application of steel structure of newbuildings. The protective coatings for specific space of ships are to comply with relevant requirements of Chapter 5 of the Guidelines.

4.1.2 For the surface preparation and coating application of other steel structures, reference may be made to the relevant provisions of this Chapter.

4.2 General requirements

4.2.1 A coating specification is to be agreed upon between the owner, the shipyard and the coating manufacturer in relation to the coating type, surface preparation, coating application, acceptance criteria and inspection prior to the commencement of construction of a ship. The application and inspection of protective coatings are to be carried out in accordance with the coating specification.

4.2.2 The coating type is to be selected as a function of areas to be applied, structural materials and application of other corrosion prevention systems, e.g. cathodic protection or other alternatives.

4.3 Structural design of anticorrosion area of coatings

4.3.1 The coating performance is to be improved by adopting measures at the ship design stage such as reducing scallops, using rolled profiles, avoiding complex geometric configurations and ensuring that the structural configuration permits easy access for tools and to facilitate cleaning, drainage and drying of the space to be coated.

4.3.2 Hollow members or narrow spaces which are not used and can not permit access during the service are to be avoided in so far as practicable at the ship design stage. Where it is impracticable, consideration may be given to the permanent sealing of hollow members or narrow spaces by means of welding or other reliable permanent sealing methods.

4.3.3 For compartments with protective coatings, appropriate measures are to be adopted to protect the positions subject to frequent liquid erosion during the service, e.g. fitting a damper or increasing the thickness of bottom plating appropriately.

4.4 Environmental conditions

4.4.1 Where blast cleaning and flow line of shop primer application are used for primary surface preparation of steel in the workshop, the operation areas of blast cleaning and coating application are to be well separated. The operation area of coating application is to be maintained for clean environment and circulation of air.

4.4.2 The surface temperature of steel, the relative humidity and the dew point are to be measured and recorded before the blast cleaning and coating application start, at times of sudden changes in weather and where there is possibility of dew appearance. The blast cleaning or coating application may be carried out only when:

(1) the relative humidity is not to exceed 85%;

(2) the surface temperature is at least 3℃ above the dew point;

(3) the requirements of the coating specification are complied with.

4.5 Primary surface preparation of steel

4.5.1 The steel surface is to be relatively clean before the blast cleaning. Any oil, grease and other contamination on the steel surface is to be removed before the blast cleaning in so far as practicable.

4.5.2 The primary surface preparation of steel may be carried out by means of blast cleaning.

4.5.3 The quality of abrasive used in the blast cleaning is to be controlled by the shipyard, including type, size, contaminant and any hazardous substance during recycled use of abrasive.

4.5.4 On completion of primary surface preparation, the cleanliness and profile of steel surface are to comply with requirements of the coating specification.

4.5.5 On completion of primary surface preparation, the shop-primer is to be applied immediately in accordance with requirements of the coating specification.

4.6 Secondary surface preparation of steel

4.6.1 The steel surface is to be prepared so that the coating selected can achieve an even distribution at the required NDFT and have an adequate adhesion by removing sharp edges, grinding weld beads and removing weld spatter and any oil, grease and other visible surface contaminant in so far as practicable.

4.6.2 In general, the secondary surface preparation is to be carried out by means of blast cleaning, power tool grinding and hand de-rusting.

4.6.3 The technology and requirements with regard to the secondary surface preparation are to comply with Table 4.6.3.

Technology and requirements with regard to the secondary surface preparation **Table 4.6.3**

Range	Technology	General requirements
Weld area	a) blast cleaning b) power tool grinding	a) to remove the coked, bubbled and discolored film at both sides of bead and the film with bottom layer damaged by heating within 30～50 mm range around b) to remove black skin and yellow rust on the surface of and at both sides of bead
Burnt area	a) blast cleaning b) power tool grinding	a) to remove the coked, bubbled and discolored film and the film with bottom layer damaged by heating within 30～50 mm range around b) where the film thickness is greater than 50 μm, the coating within 25～30 mm range of the above-mentioned areas is to form a slope

Range	Technology	General requirements
Natural corrosion and mechanical damage areas	a) blast cleaning b) power tool grinding	a) to remove film and yellow rust in corrosion area/ mechanical damage area and within 20～25 mm range around b) where the film thickness is greater than 50μm, the coating within 25～30 mm range of the above-mentioned areas is to form a slope
Intact shop-primer area	a) blast cleaning b) power tool grinding	a) to remove white rust on the shop-primer surface by light blast cleaning or light power tool grinding b) to rough lightly and clean the surface c) special positions to be treated in accordance with the technical requirements of the relevant paint
Difficult operating area, e.g. reverse side, corner, edge of profile steel	a) blast cleaning b) power tool grinding c) hand de-rusting	To remove the black skin and yellow rust on the surface as far as possible and eliminate the sharp edges in areas with higher anticorrosive requirements

4.6.4 On completion of the secondary surface preparation, the condition of surface to be coated is to comply with requirements of the coating specification and the primer coat is to be applied in time.

4.7 Coating application technology

4.7.1 In general, coating is applied by means of brush, roller, air spray and airless spray.

4.7.2 The paint to be used is to be fully mixed and pre-cured prior to application. The mixed paint is to be used up during its pot life. Thinner is to be limited to those types and quantities recommended by the manufacturer.

4.7.3 For areas where it is hard to spray or where it is hard to meet film thickness requirement in some spaces with high anticorrosive requirements, stripe coating is to be applied prior to (or after) coating application.

4.7.4 The coating is to be applied in accordance with the coating type and dry film thickness as specified in the coating specification. The maximum dry film thickness of each coat is to comply with the coating manufacturer's recommendation, so as to avoid increasing the thickness in an exaggerated way. The wet film thickness may be measured to achieve appropriate dry film thickness, if necessary.

4.7.5 The environmental conditions during the drying or curing of the paint are to be controlled, as recommended by the coating manufacturer, for the proper drying or curing of the paint.

4.7.6 The dry-to-recoat times are to be noted for the coating application of a multi-coat system to ensure that each coating layer is appropriately dried or cured, and that surface contaminants are removed in so far as practicable before application of the next coat. The coating surface is to be roughed when the maximum interval is exceeded.

4.7.7 Any defective areas, e.g., pin-holes, bubbles, voids, etc., are to be marked up and appropriate repairs effected.

4.7.8 During the coating application, due attention is to be given to the protection of areas to be coated or areas with un-dried coating, e.g. fitting a temporary protective rail or warning notice. The scallops in areas to be coated or areas with un-dried coating are to be suitably and temporarily plugged, drained or sealed.

4.8 Coating application procedure

4.8.1 The coating application of erection units is to be carried out after completion of the delivery inspection of structural integrity and the pre-outfitting work. Leak testing is to be carried out, prior to the application of a protective coating, on all fillet weld connections on tank boundaries, penetrations and erection welds on tank boundaries excepting welds made by automatic processes. Prior to the coating application, masking tape may be stuck on the areas not intended to be coated temporarily or suitable measures are to be taken for protection of such areas.

4.8.2 Where impressed current protection is used for ships, anodic shield is to be applied or fitted in auxiliary anodic zones prior to the coating application.

4.8.3 After completion of the coating application of erection units, they are to be moved only after the coating is appropriately dried or cured. For the non-fully-open compartments in the units, the concentration of dissolvent gas is to be measured, and they are to be moved only after the required range is met as confirmed.

4.8.4 The bottom unit is to be up on the berth only after the coating of shell plate is appropriately dried or cured. Bedding made of soft material with good dissolvent resistance is to be used in way of blocks.

4.8.5 If the ship is to be launched and not docking, the positions under waterline (including waterline depth gauge) is to be coated completely prior to the launching. If the positions where the ship's bottom is contacted with blocks or pillars of berth can not be coated in advance, proper measures are to be taken to ensure the integrity of such coating in these positions prior to the ship's launching.

4.8.6 For the coating in the interior of tanks to be under water after launching, repair is to be finished prior to the launching. Otherwise, measures of ventilation, dehumidification are to be taken, so that repair is to be carried out under the condition of surface temperature of steel plate at least 3℃ higher than the dew point.

4.8.7 Where the shell plate is to be coated in dock before a new ship is delivered, high-pressure washing is to be carried out first, to remove the sludge and impurities. If there is grease, dissolvent or chemical cleaning agent is to be used. If there is water in tanks directly contacted with shell plate, and the water droplets might condense due to temperature difference, the water is to be discharged completely so as not to affect the coating application.

4.9 Coating inspection

4.9.1 Coating inspectors are to inspect surface preparation and coating application during the coating process. Emphasis is to be placed on initiation of each stage of surface preparation and coatings application as improper work is extremely difficult to correct later in the coating progress. Representative structural members are to be non-destructively examined for coating thickness. The inspector is to verify that appropriate collective measures have been carried out.

4.10 Health and safety

4.10.1 The shipyard/contractor is responsible for implementation of national regulations to ensure the health and safety of individuals and to minimize the risk of fire and explosion.

4.10.2 The coating application workshop is to have safety equipment such as illumination, robust staging, etc.

4.10.3 Adequate ventilation is necessary for ensuring that the concentration of flammable gas is within safety range. Ventilation is to be maintained throughout the application process and for a period after application is completed, as recommended by the coating manufacturer.

4.10.4 Means for fire protection are to be provided for storage, transportation and use of paint. During the coating application, naked fire operation is to be prohibited in the conservation zones by the shipyard and the generation of static electricity is to be prevented.

4.10.5 The handling of paint waste package is to comply with the relevant national regulations.

CHAPTER 5 PROTECTIVE COATINGS FOR SPECIFIC SPACES OF SHIPS

5.1 Application

5.1.1 For ships applying for protective coating notations referred to in Chapter 1 of the Guidelines, the protective coatings for specific spaces are to comply with requirements of this Chapter.

5.1.2 Specific spaces referred to in this Chapter are as follows:

(1) Dedicated seawater ballast tanks are tanks which are exclusively for sea water ballast on all types of seagoing ships of not less than 500 gross tonnage engaged on international voyage, excluding ballast tank identified as "Spaces included in Net Tonnage" in the 1969 ITC Certificate and sea water ballast tanks in passenger vessels also designated for the carriage of grey water.

(2) Double-side skin spaces of bulk carriers are spaces of bulk carriers with the class notation of "double side skin" complying with CCS Rules for Classification of Sea-going Steel Ships.

(3) Void space of bulk carriers and oil tankers is an enclosed space (which has no means of access and no ventilation) below the bulkhead deck, within and forward of, the cargo area of oil tankers or the cargo length area of bulk carriers, excluding a dedicated seawater ballast tank, a space for the carriage of cargo, a space for the storage of any substance (e.g., oil fuel, fresh water, provisions), a space for the installation of any machinery (e.g., cargo pump, ballast pump, bow thruster), any space in normal use by personnel and a double-side skin space of bulk carriers. "Cargo area" and "cargo length area" are as defined in resolution A.744 (18).

(4) Cargo oil tanks of crude oil tankers are as defined in Annex I of MARPOL 73/78.

5.2 General requirements

5.2.1 The ability of the coating system to reach its target useful life depends on the type of coating system, steel preparation, application and coating inspection and maintenance. All these aspects contribute to the good performance of the coating system.

5.2.2 Prior to the commencement of construction of a ship, inspection of surface preparation and coating processes agreement is to be agreed upon between the shipowner, the shipyard and the coating manufacturer and presented by the shipyard to CCS for review. CCS may, if it so requires, participate in the agreement process. Clear evidence of these inspections is to be reported and be included in the Coating Technical File. The tripartite inspection agreement is at least to cover:

(1) inspection process, including scope of inspection, who carries out the inspection, the qualifications of the coating inspector(s) and appointment of a qualified coating inspector (responsible for verifying that the coating is applied in accordance with the requirements). Where more than one coating inspector will be used then their areas of responsibility are to be identified (for example, multiple construction sites);

(2) language to be used for documentation.

5.2.3 In order to achieve the coating performance as specified in this Chapter, the following are to be taken into account:

(1) it is essential that specifications, procedures and the various different steps in the coating application process (including, but not limited to, surface preparation) are strictly applied by the shipbuilder in order to prevent premature decay and/or deterioration of the coating system;

(2) the coating performance can be improved by adopting measures at the ship design stage such as reducing scallops, using rolled profiles, avoiding complex geometric configurations and ensuring that the structural configuration permits easy access for tools and to facilitate cleaning, drainage and drying of the space to be coated;

(3) the coating performance standard provided in this Chapter is based on experience from manufacturers, shipyards and ship operators; it is not intended to exclude suitable alternative coating systems, providing a performance at least equivalent to that specified in this Chapter is demonstrated. Acceptance criteria for alternative systems are provided in 5.7 of the Guidelines.

5.2.4 Specification of the coating system applied to specific spaces of ships, record of the shipyard' s and shipowner's coating work, detailed criteria for coating selection, job specifications, inspection, maintenance and repair are to be documented in the Coating Technical File (CTF), and the Coating Technical File is to be reviewed by CCS.

(1) The Coating Technical File is to be delivered by the shipyard for review by CCS and is to contain at least the following items at the new ship construction stage:

a. copy of Statement of Compliance or Type Approval Certificate;

b. copy of Technical Data Sheet, at least including:
product name and identification mark and/or number;
materials, components and composition of the coating system, colours;
minimum and maximum dry film thickness;
application methods, tools and/or machines;
condition of surface to be coated (de-rusting grade, cleanness, profile, etc.);
environmental limitations (temperature and humidity);

c. Material Safety Data Sheet (MSDS);

d. coating specification, at least including:
scope of coating application;
type of coating system;
steel preparation;
surface preparation;
surface cleanliness;
environmental conditions;
application procedure;
acceptance criteria and inspection;

e. shipyard work records of coating application, at least including:
applied actual space and area (in square metres) of each compartment;
applied coating system;
time of coating, thickness, number of layers, etc.;

ambient condition during coating;
method of surface preparation;

f. procedures for inspection and repair of coating system during ship construction;

g. results from the inspection issued by the coating inspector, stating that the coating was applied in accordance with the specifications to the satisfaction of the coating supplier representative and specifying deviations from the specifications (example of daily log and non-conformity report (see appendix A));

h. shipyard's verified inspection report, at least including:
completion date of inspection;
result of inspection;
remarks (if given);
inspector signature;

i. procedures for in-service maintenance and repair of coating system;

j. tripartite inspection agreement.

(2) Maintenance, repair and partial re-coating activities are to be recorded in the Coating Technical File in accordance with the relevant requirements of Chapter 8 of the Guidelines. Attention is to be paid to the coating maintenance of permanent means of access provided for inspection in dedicated seawater ballast tanks and double-side skin spaces of bulk carriers.

(3) If a full re-coating is carried out, the items specified in 5.2.4(1) are to be recorded in the Coating Technical File.

(4) The Coating Technical File is to be kept on board and maintained throughout the life of the ship.

5.2.5 Health and safety are to comply with relevant requirements of 4.10 of the Guidelines.

5.3 Coating performance

5.3.1 This Chapter is based on specifications and requirements which intend to provide a target useful coating life of 15 years, which is considered to be the time period, from initial application, over which the coating system is intended to remain in "GOOD" condition (as defined in Table 8.2.3 of the Guidelines). The actual useful life will vary, depending on numerous variables including actual conditions encountered in service.

5.3.2 The scope of coating application for specific spaces as specified in the Guidelines is as follows:

(1) dedicated seawater ballast tanks;

(2) double-side skin spaces of bulk carriers;

(3) protective coatings are to be applied at least in the following areas of cargo oil tanks of crude oil tankers, as shown in Fig. 5.3.2.

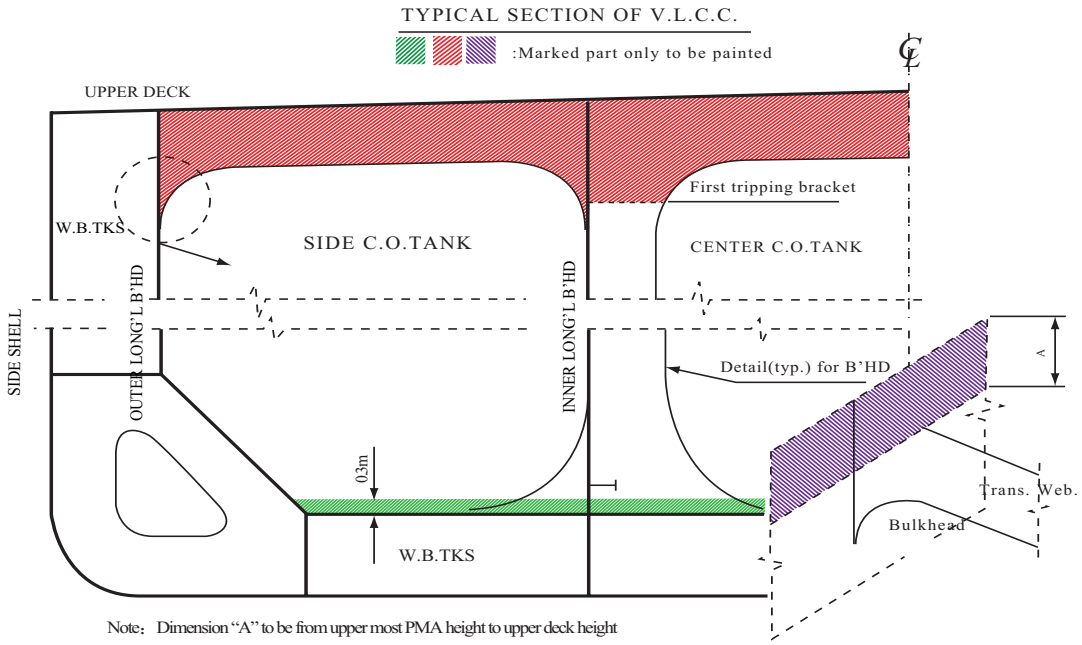


Fig. 5.3.2 Area of application of cargo oil tanks of crude oil tankers

a. Deckhead with complete internal structure, including brackets connecting to longitudinal and transverse bulkheads. In tanks with ring frame girder construction the underdeck transverse framing to be coated down to level of the first tripping bracket below the upper faceplate.

b. Longitudinal and transverse bulkheads to be coated to the uppermost means of access level. The uppermost means of access and its supporting brackets are to be fully coated.

c. On cargo tank bulkheads without an uppermost means of access the coating to extend to 10% of the tanks height at centreline but need not extend more than 3 m down from the deck.

d. Flat inner bottom and all structure to height of 0.3 m above inner bottom to be coated.

(4) Void spaces of bulk carriers and oil tankers are divided into three categories, as shown in Table 5.3.2.

Category of void spaces on bulk carriers and oil tankers Table 5.3.2

	Oil tankers	Bulk carriers
Category I	double-side skin (DSS) voids including sides, bottoms/double hull voids spaces protecting cargo oil tanks	upper and lower side void spaces and double bottoms void spaces in cargo area
Category II	.1 forward cofferdam/cofferdam separating cargo from forepeak; .2 cofferdam in cargo area/cofferdam separating incompatible cargoes; .3 aft cofferdam; .4 duct keel/pipe tunnels; .5 lower bulkhead stools; .6 upper bulkhead stools	.1 double bottom pipe passages / pipe tunnels; .2 small void spaces located behind gusset or shedder plates at the bottom of corrugation bulkheads with the exception of totally enclosed spaces; .3 other small void spaces in cargo spaces, with the exception of totally enclosed spaces; .4 lower transverse stool of transverse bulkheads, with the exception of totally enclosed spaces; .5 upper transverse stool of transverse bulkheads, with the exception of totally enclosed spaces

	Oil tankers	Bulk carriers
Category III	.1 totally enclosed spaces located behind gusset or shedder plates at the bottom of corrugation bulkheads and other small totally enclosed spaces in cargo tanks; .2 lower transverse stool of transverse bulkheads that are totally enclosed spaces; .3 upper transverse stool of transverse bulkheads that are totally enclosed spaces; .4 transducer voids; .5 any spaces not specifically mentioned in Category I and II of this Table	

In table 5.3.2, category I void spaces in bulk carriers and oil tankers are to be coated in accordance with requirements for dedicated seawater ballast tanks and double-side skin spaces of bulk carriers; category II void spaces in bulk carriers and oil tankers are to be coated in accordance with requirements for void spaces of bulk carriers and oil tankers; No requirements are contained in this Chapter for protective coatings for Category III void spaces in bulk carriers and oil tankers.

5.3.3 This Chapter covers protective coating requirements for steel structures of specific spaces of ships, and corrosion protection of outfitting in specific space is to comply with the following requirements:

(1) Permanent means of access arrangements that are integral to the ship structure are to be coated in accordance with requirements for specific spaces where these PMAs are fitted.

(2) It is suggested that hot dip galvanizing is to be employed as the primary means for corrosion protection for PMAs that are not integral to the ship structure. Hot dip galvanizing is to be performed in accordance with ISO 1461:1999. The galvanized items are to be subsequently coated to ISO 12944-5:2007 or the coating manufacturer's recommendation. The type of paint is to be selected considering its compatibility requirements with the galvanized surface in accordance with the coating manufacturer's recommendation.

(3) Where protective coating is applied as the sole means of corrosion protection for PMAs that are not integral to the ship structure, the requirements for specific spaces where these PMAs are fitted are to be applied to the extent possible. In such cases, the protective coating is to at least comply with the requirements for the job specification, coating system (epoxy-based system) and total NDFT.

(4) It is also recommended that supports for piping, measuring devices, etc., be coated in accordance with the provisions for non-integral items indicated in 5.3.3(2) and (3).

5.3.4 The requirements for surface preparation and coating application of protective coating systems at ship construction for specific spaces of ships are listed in Table 5.3.4.

(1) Coating manufacturers are to provide a specification of the protective coating system to satisfy the requirements of Table 5.3.4.

(2) CCS is to verify the Technical Data Sheet and Statement of Compliance or Type Approval Certificate for the protective coating system.

(3) The shipyard is to apply the protective coating in accordance with the verified coating specification, Technical Data Sheet and its own verified application procedures.

Requirements for surface preparation and coating application of protective coating systems at ship construction for specific spaces of ships Table 5.3.4

Specific spaces		Dedicated seawater ballast tanks, double-side skin spaces of bulk carriers and category I void spaces in bulk carriers and oil tankers	Cargo oil tanks of crude oil tankers	Category II void spaces in bulk carriers and oil tankers
1 Design of coating system				
.1	Selection of the coating system	The selection of the coating system is to be considered by the parties involved with respect to the service conditions and planned maintenance. The following aspects, among other things are to be considered: .1 location of space relative to heated surfaces; .2 frequency of ballasting and deballasting operations; .3 required surface conditions; .4 required surface cleanliness and dryness; .5 supplementary cathodic protections, if any (where coating is supplemented by cathodic protection, the coating is to be compatible with the cathodic protection system)	The selection of the coating system is to be considered by the parties involved with respect to the service conditions and planned maintenance. The following aspects, among other things are to be considered: .1 location of space relative to heated surfaces; .2 frequency of cargo operations; .3 required surface conditions; .4 required surface cleanliness and dryness; .5 supplementary cathodic protections, if any (where coating is supplemented by cathodic protection, the coating is to be compatible with the cathodic protection system); .6 permeability of the coating and resistance to inert gas and acids; .7 appropriate mechanical properties (flexibility, impact resistance)	The selection of the coating system is to be considered by the parties involved with respect to the service conditions and planned maintenance. The following aspects, among other things are to be considered: .1 location of space relative to heated surfaces; .2 required surface conditions; .3 required surface cleanliness and dryness; .4 relative humidity; .5 access and maintenance; .6 mechanical ventilation
		Coating manufacturers are to have products with documented satisfactory performance records and technical data sheets. The manufacturers are also to be capable of rendering adequate technical assistance. Performance records, technical data sheet and technical assistance (if given) are to be recorded in the Coating Technical File. Coatings for application underneath sun-heated decks or on bulkheads forming boundaries of heated spaces are to be able to withstand repeated heating and/or cooling without becoming brittle.		

Specific spaces		Dedicated seawater ballast tanks, double-side skin spaces of bulk carriers and category I void spaces in bulk carriers and oil tankers	Cargo oil tanks of crude oil tankers	Category II void spaces in bulk carriers and oil tankers
.2	Coating type	Epoxy-based systems or an equivalent coating system, with corresponding CCS products approval certificate. A multi-coat system with each coat of contrasting colour is recommended. Top coat of a coating system is to be of a light colour, which reflects light to an extent that a simple flash light (hand torch) will make inspection easy and fast, normally light grey, buff, off-white, swimming pool blue/green etc. easily distinguishable from rust		
		—	Consideration is to be given to the use of enhanced coatings in way of suction bellmouths and heating coil downcomers. Consideration is to be given to the use of supplementary cathodic protection where there may be galvanic issues.	—
.3	Job specification	There are to be a minimum of two stripe coats and two spray coats, except that the second stripe coat, by way of welded seams only, may be reduced in scope where it is proven that the NDFT can be met by the coats applied, in order to avoid unnecessary over-thickness. Any reduction in scope of the second stripe coat is to be fully detailed in the CTF. Stripe coats are to be applied by brush or roller. Stripe coats are to be applied as a coherent film showing good film formation and no visible defects. The application method employed is to ensure that all areas that require stripe coating are properly coated by brush or roller. A roller may be used for scallops, ratholes etc., but not for edges and welds		There are to be a minimum of one stripe coat and one spray coat. The stripe coat is to be applied on thermally cut free edges and small holes only
		Each main coating layer is to be appropriately cured before application of the next coat, in accordance with coating manufacturer's recommendations. Surface contaminants such as rust, grease, dust, salt, oil, etc., are to be removed prior to painting with proper method according to the paint manufacturer's recommendation. Abrasive inclusions embedded in the coating are to be removed. Job specifications are to include the dry-to-recoat times and walk-on time given by the manufacturer		
.4	NDFT (nominal total dry film thickness)①②	NDFT is not to be less than the dry film thickness as specified in corresponding CCS products approval certificate and not less than 320 μm		NDFT is not to be less than the dry film thickness as specified in corresponding CCS products approval certificate and not less than 200 μm
		90/10 rule for epoxy-based coatings; other systems to corresponding CCS products approval certificate. Maximum dry film thickness of each coat according to manufacturer's recommendations. Care is to be taken to avoid increasing the thickness in an exaggerated way. Wet film thickness is to be checked during application, as required. Thinner is to be limited to those types and quantities recommended by the manufacturer		
2 PSP (Primary surface preparation)				

Specific spaces		Dedicated seawater ballast tanks, double-side skin spaces of bulk carriers and category I void spaces in bulk carriers and oil tankers	Cargo oil tanks of crude oil tankers	Category II void spaces in bulk carriers and oil tankers
.1	Blasting and profile③④⑤	Sa 2½ with profiles between 30-75 μm. Rust grade D steel is not applicable to the construction of specific spaces of ships. Blasting is not to be carried out when: .1 the relative humidity is above 85%; or .2 the surface temperature of steel is less than 3℃ above the dew point. Checking of the steel surface cleanliness and roughness profile is to be carried out at the end of the surface preparation and before the application of the primer, in accordance with the manufacturer's recommendations		
.2	Water soluble salt limit (equivalent to NaCl)⑥	⩽ 50 mg/m² of sodium chloride		
.3	Shop primer	Zinc containing inhibitor free zinc silicate based or equivalent. Compatibility with main coating system is to be confirmed by the coating manufacturer		
3 Secondary surface preparation				
.1	Steel condition⑦	The steel surface is to be prepared so that the coating selected can achieve an even distribution at the required NDFT and have an adequate adhesion by removing sharp edges, grinding weld beads and removing weld spatter and any other surface contaminant		
		Edges are to be treated to a rounded radius of minimum 2 mm, or subjected to three pass grinding or at least equivalent process before painting. Where dedicated form-grinding tools are used, one pass grinding may be treated as equivalent process		Edges to be smooth, subject to one pass grinding or at least equivalent process before painting
.2	Surface treatment③	Sa 2½ on damaged shop primer and welds		Sa 2 or St 3 on damaged shop primer and welds
		If the compatibility of the shop-primer and the main coating to be applied is confirmed by CCS products approval certificate, the intact shop-primer may be retained. The retained shop primer is to be cleaned by sweep blasting, high-pressure water washing or equivalent method, otherwise Sa 2 is to be achieved by removing at least 70% of intact shop primer		
.3	Surface treatment after erection③	Butts St 3 or better or Sa 2½ where practicable		Butts St 3 or better or Sa 2 where practicable

Specific spaces		Dedicated seawater ballast tanks, double-side skin spaces of bulk carriers and category I void spaces in bulk carriers and oil tankers	Cargo oil tanks of crude oil tankers	Category II void spaces in bulk carriers and oil tankers
		Erection joint (“butt”) is generally centered on the connected welds and the width on both sides of the erection butt does not exceed 200 mm. Burning damage on the reverse side due to erection may be categorized as erection joint (“butt”). For pre-welded fillet welds kept for erection of girders or stiffeners between blocks, the areas within 100 mm around the weld (as the center) may be categorized as erection joint (“butt”), as shown in Fig.5.3.4. Usually, the fillet welding on tank boundary watertight bulkhead is left without coating on block stage (because not yet be leakage tested), in which case it may be categorized as erection joint (“butt”)		

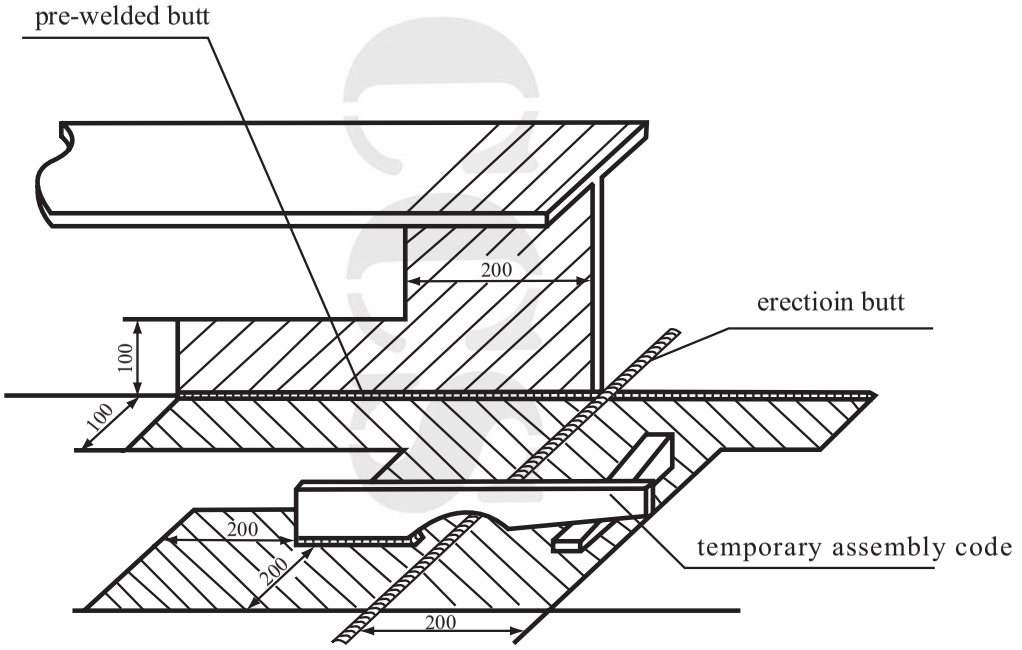


Fig. 5.3.4 Diagram of erection butt

Specific spaces		Dedicated seawater ballast tanks, double-side skin spaces of bulk carriers and category I void spaces in bulk carriers and oil tankers	Cargo oil tanks of crude oil tankers	Category II void spaces in bulk carriers and oil tankers
		- Damages up to 2% of the area to be coated to be treated to minimum St 3. - Contiguous damages over 25 m^2 or over 2% of the area to be coated, Sa 2½ is to be applied.	For Inner Bottom: - Damages up to 20% of the area to be coated to be treated to minimum St 3. - Contiguous damages over 25 m^2 or over 20% of the area to be coated, Sa 2½ is to be applied. For Underdeck: - Damages up to 3% of area to be coated to be treated to minimum St 3. - Contiguous damages over 25 m^2 or over 3% of the area to be coated, Sa 2½ is to be applied.	
		Damages mean, areas where the damage reaches the shop primer or steel surface. Contiguous damage here refers to neighbouring coating damages, where the individual damages are at a distance of not exceeding 100 mm. The percent of the damaged area is the ratio of the damaged area needing repair to the total tank area in the stage of block assembly/erection. Erection butt is excluded in the percent calculating. The damaged area is determined by the inspector. While dispute arises, the method of scribing matrix on the photos and calculating area may be used for large damage area and direct measure of the length may be used for linear damage		
		Coating in overlap is to be feathered		
.4	Profile requirements④	In case of full or partial blasting 30-75 μm, otherwise as recommended by the coating manufacturer		
.5	Dust[8]	Dust quantity rating “1” for dust size class “3”, “4” or “5”. Lower dust size classes to be removed if visible on the surface to be coated without magnification. Lower dust size is the size less than size class “3”, and is to be removed if visible to the eye when accumulated		Dust quantity rating “2” for dust size class “3”, “4” and “5”
.6	Water soluble saltslimit equivalent to NaCl after blasting/ grinding⑥	⩽ 50 mg/m^2 of sodium chloride		⩽ 100 mg/m^2 of sodium chloride

Specific spaces		Dedicated seawater ballast tanks, double-side skin spaces of bulk carriers and category I void spaces in bulk carriers and oil tankers	Cargo oil tanks of crude oil tankers	Category II void spaces in bulk carriers and oil tankers
.7	Oil contamination	No oil contamination		
4 Miscellaneous				
.1	Ventilation	Adequate ventilation is necessary for the proper drying and curing of coating. Ventilation is to be maintained throughout the application process and for a period after application is completed, as recommended by the coating manufacturer		
.2	Environmental condition	Coating is to be applied under controlled humidity and surface conditions, in accordance with the manufacturer's specifications. In addition, coating or blasting is not to be applied when: (1) the relative humidity is above 85%; or (2) the surface temperature is less than 3℃ above the dew point		
.3	Testing of coating①	Destructive testing is to be avoided. Dry film thickness is to be measured after each coat for quality control purpose and the total dry film thickness is to be confirmed after completion of final coat, using appropriate thickness gauges		
.4	Repair	Any defective areas, e.g., pin-holes, bubbles, voids, etc., are to be marked up and appropriate repairs effected. All such repairs are to be re-checked and documented		

① Type of gauge and calibration in accordance with SSPC-PA2:2004. Paint Application Specification No.2.

② A 90/10 practice means that 90% of all thickness measurements are to be greater than, or equal to, NDFT and none of the remaining 10% measurements are to be below 0.9 × NDFT.

③ Surface cleanliness measured in accordance with ISO 8501-1:1988/Suppl:1994. Preparation of steel substrate before application of paints and related products – Visual assessment of surface cleanliness.

④ Surface profile measured in accordance with ISO 8503-1/2:1988. Preparation of steel substrate before application of paints and related products – Surface roughness characteristics of blast-cleaned steel substrates.

⑤ Rust grade in accordance with ISO 8501-1:1988/Suppl:1994. Preparation of steel substrate before application of paints and related products – Visual assessment of surface cleanliness.

⑥ The conductivity of soluble salts is measured in accordance with ISO 8502-6 and ISO 8502-9:1998, and compared with the conductivity of the specified limit equivalent to NaCl. If the measured conductivity is less than or equal to, then it is acceptable.

⑦ Reference standard: ISO 8501-3:2001 (grade P2). Preparation of steel substrate before application of paints and related products – Visual assessment of surface cleanliness.

⑧ Reference standard: ISO 8502-3:1993. Preparation of steel substrate before application of paints and related products – Test for the assessment of surface cleanliness.

5.4 Coating system approval

5.4.1 Results from relevant tests, carried out in laboratories approved by CCS, of the coating system for specific spaces of ships are to be documented and a Statement of Compliance or Type Approval Certificate may be requested from CCS if the results are found satisfactory.

5.5 Coating inspection requirements

5.5.1 The qualification of coating inspectors engaged in the coating inspection of specific spaces of ships is to comply with requirements of Chapter 2 of the Guidelines.

5.5.2 Coating inspection is to comply with relevant requirements of 4.9.1 of the Guidelines. As a minimum, those inspection items identified in 5.5.4 are to be carried out. Emphasis is to be placed on initiation of each stage of surface preparation and coatings application as improper work is extremely difficult to correct later in the coating progress. Representative structural members are to be non-destructively examined for coating thickness. The inspector is to verify that appropriate collective measures have been carried out.

5.5.3 Results from the inspection issued by the coating inspector, stating that the coating was applied in accordance with the specifications to the satisfaction of the coating supplier representative and specifying deviations from the specifications (example of daily log and non-conformity report (see appendix A)) are to be included in the CTF.

5.5.4 Coating inspection items are specified in Table 5.5.4.

Coating inspection items **Table 5.5.4**

Construction stage		Inspection items
Primary surface preparation	1	The surface temperature of steel, the relative humidity and the dew point are to be measured and recorded before the blast cleaning starts, at times of sudden changes in weather and where there is possibility of dew appearance
	2	On completion of primary surface preparation and before the application of the shop-primer, the surface of steel plates is to be tested for profiles, soluble salt and checked for oil, grease and other contamination. For measurement of the conductivity of soluble salts, minimum readings to be taken are one (1) per plate in the case of manually applied shop-primer. In cases where an automatic process for application of shop-primer is used, the inspection is not required where the coating inspector confirms that the quality control system for automated shop-primer plants includes the following procedures: (1) Procedures for management of the blasting grit including measurement of salt and contamination. (2) Procedures recording the following: steel surface temperature, relative humidity, dewpoint. (3) Procedures for controlling or monitoring surface cleanliness, surface profile, oil, grease, dust and other contamination. (4) Procedures for recording/measuring soluble salts of the steel surface. (5) Procedures for verifying thickness and curing of the shop primer conform to the values specified in the coating specification. (6) The above procedures are to be carried out at least once per month
	3	The cleanliness of the steel surface is to be monitored in the shop-primer application process
	4	The shop-primer material is to be confirmed to meet the requirements

Construction stage		Inspection items
Thickness		If compatibility with the main coating system has been declared, then the thickness and curing of the zinc silicate shop primer are to be confirmed to conform to the specified values
Block assembly	1	After completing construction of the block and before secondary surface preparation starts, a visual inspection for steel surface treatment including edge treatment is to be carried out. Any oil, grease or other visible contamination is to be removed
	2	After blasting/grinding/cleaning and prior to coating, a visual inspection of the prepared surface is to be carried out. On completion of blasting and cleaning and prior to the application of the first coat of the system, the steel surface is to be tested for levels of remaining soluble salts in at least one location per block
	3	Oil, grease, other contamination and curing quality are to be checked before application of the next coat
	4	The surface temperature, the relative humidity and the dew point are to be monitored and recorded during the coating application and curing
	5	Inspection is to be performed of the steps in the coating application process
	6	DFT measurements are to be taken to prove that the coating has been applied to the thickness as specified and outlined in appendix B. Dry film thickness is to be measured after each coat and the total dry film thickness is to be measured and reported for compliance with the requirements after completion of final coat, by the qualified coating inspector using appropriate thickness gauges. The Coating Technical File may contain a summary of the DFT measurements which typically will consist of minimum and maximum DFT measurements, number of measurements taken and percentage above and below required DFT. The final DFT compliance with the 90/10 practice is to be calculated and confirmed
Erection	1	Visual inspection for steel surface condition, surface preparation and verification of conformance to other requirements, and the agreed specification is to be performed
	2	The surface temperature, the relative humidity and the dew point are to be measured and recorded before coating starts and regularly during the coating process
	3	Inspection is to be performed of the steps in the coating application process

5.6 Verification requirements

5.6.1 The following are to be carried out by CCS prior to reviewing the Coating Technical File:

(1) check that the Technical Data Sheet and Statement of Compliance or Type Approval Certificate comply with this Chapter;

(2) check that the coating identification on representative containers is consistent with the coating identified in the Technical Data Sheet and Statement of Compliance or Type Approval Certificate;

(3) check that the inspector is qualified;

(4) check that the inspector's reports of surface preparation and the coating's application indicate compliance with the manufacturer's Technical Data Sheet and Statement of Compliance or Type Approval Certificate;

(5) monitor implementation of the coating inspection requirements, by checking that the inspectors are using the equipment, techniques and reporting methods as described in the tripartite inspection agreement reviewed by CCS.

5.7 Alternative systems

5.7.1 All systems that are not an epoxy-based system applied according to table 5.3.4 of this Chapter are defined as an alternative system.

5.7.2 This coating performance requirements of this Chapter are based on recognized and commonly used coating systems. It is not meant to exclude other alternative systems with proven equivalent performance, for example non epoxy-based systems.

5.7.3 Acceptance of alternative systems will be subject to documented evidence that they ensure a corrosion prevention performance at least equivalent to that indicated in this Chapter.

5.7.4 As a minimum, the documented evidence is to consist of satisfactory performance corresponding to that of a coating system which conforms to the coating standard described in 5.3 of this Chapter, a target useful life of 15 years in either actual field exposure for 5 years with final coating condition not less than "GOOD" (as defined in Table 8.2.3 of the Guidelines) or laboratory testing approved by CCS.

CHAPTER 6 REVIEW OF TECHNICAL DOCUMENTS OF PROTECTIVE COATINGS FOR SPECIFIC SPACES OF SHIPS

6.1 General requirements

6.1.1 This Chapter is applicable to review by CCS surveyor of technical documents of protective coatings for specific spaces in relation to applying for class notations as specified in Chapter 1 during new construction stage.

6.2 Review of tripartite inspection agreement

6.2.1 Prior to the commencement of construction of a ship, inspection of surface preparation and coating processes agreement is to be signed by the shipowner, the shipyard and the coating manufacturer and presented by the shipyard to CCS for review. CCS is to conduct review in accordance with the requirements of 5.2.2 of the Guidelines.

6.2.2 To facilitate the review, the following information is to be supplied by the shipyard:

(1) Coating specification;

(2) Copy of Statement of Compliance or Type Approval Certificate.

6.2.3 Any deviations in the inspection agreement relative to the Guidelines noted during the review are to be raised with the shipyard, which is responsible for identifying and implementing the corrective actions.

6.2.4 Surface preparation and coating application are not to be carried out until all required corrective actions have been closed out to the satisfaction of CCS.

6.3 Review of coating specification

6.3.1 The coating specification is to be provided by the shipyard detailing the requirements for coating performance of Table 5.3.4 of the Guidelines.

6.3.2 The coating specification is at least to include:

(1) scope of coating application;

(2) type of coating system;

(3) steel preparation;

(4) surface preparation;

(5) surface cleanliness;

(6) environmental conditions;

(7) application procedure;

(8) acceptance criteria and inspection.

6.4 Verification of coating inspection

6.4.1 The verification requirements of 5.6 of the Guidelines are to be carried out by CCS.

6.4.2 Any deviations found are to be raised initially with the coating inspector, who is responsible for identifying and implementing the corrective actions.

6.4.3 In the event that corrective actions are not acceptable to CCS or in the event that corrective actions are not closed out then the shipyard is to be informed.

6.4.4 A class certificate is not to be issued until all required corrective actions have been closed out to the satisfaction of CCS.

6.5 Review of Coating Technical File (CTF)

6.5.1 The shipyard is responsible for compiling the Coating Technical File (CTF) either in paper or electronic format, or a combination of the two and submitting CTF for review by CCS.

6.5.2 The Coating Technical File (CTF) is at least to contain all the information as required by 5.2.4 of the Guidelines.

6.5.3 The CTF is to be reviewed for content by CCS in accordance with 5.2.4(1) of the Guidelines.

6.5.4 Any deviations found are to be raised with the shipyard, which is responsible for identifying and implementing the corrective actions.

6.5.5 A class certificate is not to be issued until all required corrective actions have been closed out to the satisfaction of CCS.

CHAPTER 7 CATHODIC PROTECTION

7.1 General requirements

7.1.1 The requirements in this Chapter apply to cathodic protection for ship's positions under water and the submersed surface of structural interior (e.g. ballast tank).

7.1.2 In general cathodic protection is applied in the environment where liquid corrosive media exist. Cathodic protection consists of sacrificial anodic protection and impressed current protection. Impressed current protection is not to be applied in enclosed spaces.

7.1.3 During the construction and repair of the ship in water, effective measures are to be taken to prevent the stray current from corroding the hull.

7.1.4 Where the cathodic protection is necessary for the ship, cathodic protection design may be carried out in accordance with the calculation methods as specified in Appendix C and Appendix D of the Guidelines, or by means of FE cathodic protection design software. For the protective current density for cathodic protection, refer to Table 7.1.4.

Current Density of Cathodic Protection **Table 7.1.4**

No.	Protected position	Ambient medium	Protective method	Protective current mA/m^2	Remark
1	Shell plate (under water)	Seawater	Sacrificial anode	8～18	With protective coating
2	Shell plate (under water)	Seawater	Impressed current	30～50	With protective coating
3	Ballast tank	Seawater	Sacrificial anode	3～10	With protective coating
4	Offshore installation (under water)	Seawater	Impressed current	30～40	With protective coating
5	Rudder	Seawater	Sacrificial anode/ impressed current	100～150	With protective coating
6	Propeller	Seawater	Sacrificial anode	300～400	Without protective coating
			Impressed current	500	Without protective coating
7	Bare steel	Still seawater	Sacrificial anode/ impressed current	80～100	Without protective coating
8	Bare steel	Flowing seawater	Sacrificial anode/ impressed current	100～150	Without protective coating

7.1.5 Cathodic protection devices such as sacrificial anode, potentiostat, reference electrode and auxiliary electrode are to be approved by CCS. Approval may be requested for impressed current protection system as a whole system.

7.1.6 For connection of material with apparent difference of electrode potential (e.g. carbon steel and Austenitic stainless steel or aluminum alloy), consideration is to be given to appropriate insulation means to reduce the galvanic corrosion.

7.1.7 Prior to the commencement of construction of ship, the plans and documents as required in 7.2 are at least to be submitted to CCS for information.

7.2 Plans and documents

7.2.1 For design information of cathodic protection system, the following information is at least to be submitted:

(1) calculations of cathodic protection design;

(2) arrangement of sacrificial anodic protection; or

(3) arrangement of impressed current cathodic protection.

7.2.2 The calculations of cathodic protection design are to include the following:

(1) selection of cathodic protection methods;

(2) area of the protected positions (areas);

(3) protective potential range, protective current density and protective current capacity;

(4) sacrificial anodic material, size, type, weight, capacity, generating current, service life and designed service number if the sacrificial anodic protection is used (refer to Appendix C for calculation methods);

(5) type of potentiostat, type of auxiliary anode, number and weight, type of reference electrode and type of earthing devices for propeller and rudder if the impressed current protection is used (refer to Appendix D for calculation methods).

7.2.3 The arrangement of sacrificial anode is to be in compliance with the requirements of construction specifications and the arrangement of sacrificial anode is to include the following:

(1) material quality and type of sacrificial anode;

(2) size of sacrificial anode;

(3) installation type and requirement of sacrificial anode;

(4) coordinate position of sacrificial anodic arrangement.

7.2.4 The arrangement of impressed current cathodic protection is to be in compliance with the construction specifications and includes the following:

(1) type, size and coordinate position of potentiostat, auxiliary anode, reference electrode;

(2) coordinate position of earthing devices for propeller and rudder;

(3) material quality and construction requirement of anodic shield;

(4) technical requirements for installation of impressed current protection system.

7.3 Sacrificial anode

7.3.1 The sacrificial anode is to be fitted with steel core, which is capable of maintaining the anode when it is consuming. The sacrificial anode is to have sufficient rigidity to prevent resonance with its backing.

7.3.2 The electrochemical properties of sacrificial anode used in ships and offshore installations are to comply with the following requirements:

Electrochemical properties of sacrificial anode **Table 7.3.2**

Type of sacrificial anode		Open circuit potential, V	Working potential, V	Actual capacity, Ah/kg	Specific consumption, $kg*(A*a)^{-1}$	Current efficiency, %	Dissolution capacity
Sacrificial anode of Zn-Al-Cd alloy		-1.09～-1.05	-1.05～-1.00	≥780	≤11.23	≥95	The surface dissolution is to be uniform and the corrosion product is to come off easily
Sacrificial anode of Al-Zn-In series alloy	Type 1	-1.18～-1.10	-1.12～-1.05	≥2400	≤3.65	≥85	
	Type 2	-1.18～-1.10	-1.12～-1.05	≥2600	≤3.37	≥90	
Note 1: reference electrode－saturated calomel electrode. Note 2: media－artificial seawater or natural seawater is used as the seawater media. Note 3: Type 2 is Al-Zn-In-Mg-Ti anode and others belong to Type 1 anode.							

7.3.3 The working surface of the sacrificial anode is to be free from defects affecting performance, such as oxidizing slag, burr, rag, cracks, oil contamination or coating. Each sacrificial anode has a weight deviation of not more than ±3%, but the total weight is not to have negative deviation.

7.3.4 In general, the aluminum alloy anode or zinc alloy anode is to be used as ship's sacrificial anode, magnesium alloy anode is not to be recommended to use.

7.4 Arrangement of sacrificial anode

7.4.1 The sacrificial anodes of shell plate may be arranged in the whole ship in accordance with the construction specifications or arranged only in the stern. The sacrificial anodes necessary for shell plate are evenly and symmetrically arranged along the bilge keel and the stream lines before and after bilge keel.

7.4.2 The sacrificial anodes necessary for propeller and rudder are to be evenly arranged on the stern shell plate and rudder blade. However, sacrificial anode is not to be arranged on shell plate within 300 mm range of blade tip for propeller and in non-anodic zone onboard the ships with single propeller (see Fig. 7.4.2).

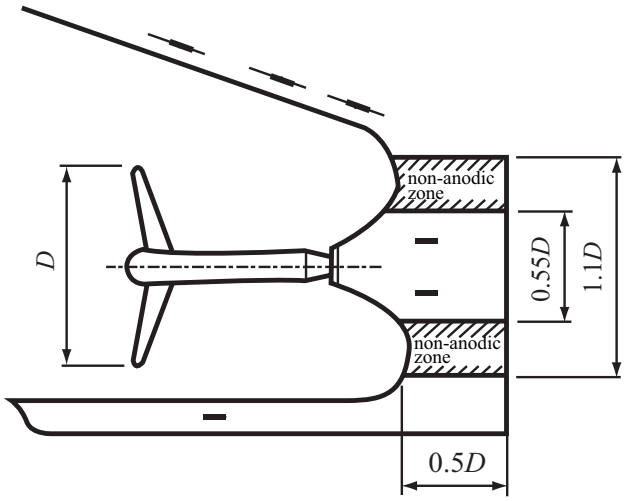


Fig. 7.4.2 Diagram of non-anodic zone of hull

7.4.3 The sacrificial anode of suction box, condenser, lateral thrust baffle and sonar transducer well is to be arranged in the interior of box, water chamber and well. For propeller duct, the sacrificial anode is to be arranged on outer wall of the duct.

7.4.4 Due consideration is to be given to the arrangement of anode near the bow to avoid damage to the anode during anchor handling.

7.4.5 The sacrificial anodes in tanks are to be reasonably arranged on the bottom and internal members. The aluminum alloy anode is allowed to be used in tanks loaded with oil, but only limited in the positions with the potential energy not exceeding 275 J. In general, the aluminum alloy anode is not to be fitted below the hatch of cargo tank and the opening of tank-washing machine. The magnesium and magnesium alloy anodes are only to be used in dedicated water ballast tanks. The positions used by zinc alloy anode may not be limited as the above-mentioned.

7.4.6 In general, the sacrificial anodes used for protection in the tank are to be evenly arranged in positions which may be submerged when the liquid level in the tank is low.

7.4.7 The sacrificial anode in the compartments is not to be fixed on shell plate and the two ends of sacrificial anode are also not to be fixed on the separating members where relative shifting probably takes place. The sacrificial anode is to be fixed on the stiffeners or the corresponding positions of plane bulkhead stiffeners.

7.4.8 The anodes are not to be arranged on the erection butt (crossing both sides). The distance between the end and the erection butt is at least 300 mm. The distance between anodes and outfitting is at least 40 mm.

7.5 Installation of sacrificial anode

7.5.1 For the sacrificial anode fitted against the surface of members, epoxy coating with the thickness not less than 150 μm is to be coated on the side which is against the member prior to installation, or a rubber gasket is to be fitted under the anode. For the sacrificial anode fixed by bolt, after the bolt is screwed down, the bolt is to be sealed by putty and the bolt hole on the anode is to be sealed.

7.5.2 The sacrificial anode and protected structure may be connected reliably by the following methods. After installation of sacrificial anode, the contact resistance between the anode and anode support is not to be greater than 0.001 Ω:

(1) the steel core is connected with structure by continuous welding with sufficient size;

(2) the steel core is connected to the backing which is continuously welded with the structure by bolts, at least two bolts wit loose-proof nuts are on each backing;

(3) other approved mechanical clamping devices.

7.5.3 Where the sacrificial anode exchange by weld probably affects the adjacent compartments (shell plate of oil tank zones, etc.), in general, steel core bolt is used for connection.

7.5.4 Where the steel core or backing is welded to the primary member, the bracket toes and the similar places where the stress is concentrated are to be avoided. Where the steel core or backing is welded to the unsymmetrical stiffener, it is to be connected with the web and the distance between weld and the edge of web is at least 25 mm. Where the stiffener or girder has symmetrical face plate, the steel core or backing may be connected to the center line of web or face plate, the free edge is to be avoided. The sacrificial anode is not to be installed on the face plate of high strength steel longitudinal as far as possible.

7.6 General requirements for impressed current protection

7.6.1 During the impressed current cathodic protective design of shell plate, in general, the range of protective potential is -0.80 V～-1.00 V (corresponding to Ag/AgCl reference electrode, the same as below). In the special case, where the arrangement positions of anode is limited, the range of protective potential may be -0.75 V～-1.00 V.

7.6.2 The impressed current protective system is to have sufficient capacity to provide protective current required by design under any conditions.

7.7 Impressed current protective devices

7.7.1 The potentiostat used in the impressed current protective system is to have the following properties:

(1) capable of working reliably under the ambient temperature of -10℃ to 55℃ and relative humidity not above 95%;

(2) capable of adapting to the heeling and rolling of 22.5°, trimming and pitching of 10°;

(3) the potential control error not greater than 0.02 V;

(4) capable of adjusting continuously within the given potential range with the adjusting accuracy not less than 0.01 V;

(5) having current-limiting or overload current protection;

(6) the input impedance not less than 1 MΩ;

(7) having metal structural shell, the shell shield type not below IP23.

7.7.2 The auxiliary anode is to have the following properties:

(1) good conductivity, large output current, long service life;

(2) the insulance between anode or conducting pole and anode stuffing box or watertight cover under dry condition (i.e. after installation of anodic structure and prior to water pressure testing) after installation is to be greater than 1 MΩ;

(3) the tightness of anodic structure under pressure of 0.2 MPa lasts for 15 min without oozing or gas leakage.

7.7.3 The reference electrode is to have the following properties:

(1) small polarization, stable properties, long service life;

(2) the insulance between reference electrode or conducting pole and hull under dry condition after installation is to be greater than 1 MΩ;

(3) the watertightness of reference electrode structure under pressure of 0.2 MPa lasts for 15 min without oozing or gas leakage.

7.7.4 The anodic shield of auxiliary anode is to have the following properties:

(1) adhesion is not to be less than 10 MPa;

(2) the anodic shield is to be without crack or peeling after 3 J drop by hammer impact;

(3) to meet the 1 grade requirement after salt fog tested for 1000 h;

(4) no flaking, breakdown or chalking after potential tested with -3.50V±0.02V (Ag/AgCl reference electrode) for 30 days.

7.7.5 The cable used for impressed current cathodic protective system is to meet the following requirements:

(1) The cable used for impressed current cathodic protective system is to be of marine type.

(2) The conducting section of cable for auxiliary anode is to be large enough so as to make the circuit voltage drop from potentiostat to anodic terminal post less than 2 V and make the circuit voltage drop of each anode as close as possible.

(3) The voltage drop of the cathodic earthing cable is to be less than 0.1 V.

(4) The shielded cable is to be used for reference electrode.

7.8 Arrangement of impressed current devices

7.8.1 In general, the potentiostat is to be arranged in engine rooms or other spaces easily to be observed and controlled. Where several potentiostats are to be provided onboard the ship, central observing and controlling devices of potentiostats are to be provided in engine room or navigation bridge.

7.8.2 For ships of more than 200 m in length, apart from the arrangement of an impressed current protection system in the stern, in general an additional impressed current protection system may be arranged in the bow.

7.8.3 The arrangement of auxiliary anodes is to be such that the potential of each position of the ship hull complies with 7.6.1. The auxiliary anodes are to be arranged symmetrically at approximately 1/3 of arc length from load waterline to the center line of bottom, but in the position about 0.5 m below the light waterline of the ship or below the low tidal level of offshore installations. Where four auxiliary anodes are arranged on the ship, two anodes are to be arranged symmetrically in the bow. Where they are arranged in the bow, areas where the electrodes may be damaged by anchoring are to be avoided.

7.8.4 The reference electrodes and the auxiliary anodes are to be arranged in the same plane. The specific position may comply with recommendations of the manufacturer. It is recommended that where two reference electrodes are arranged on the ship, they may be arranged symmetrically. Where four reference electrodes are arranged on the ship, in principle two electrodes are arranged symmetrically in the forebody and afterbody respectively. However, the reference electrodes are not to be provided within the anodic shield of auxiliary anodes. Where they are arranged in the bow, areas where the electrodes may be damaged by anchoring are to be avoided.

7.8.5 For each auxiliary anode area, consideration is to be given to the provision of anodic shield. There are to be no openings of pipes or projections within the anodic shield. The material selection, size and thickness of anodic shield for auxiliary anode are to be in compliance with the requirements recommended by the manufacturer.

7.8.6 The marine soft single core cable with the sectional area not less than 25mm2 is to be used to make the short circuit between rudderpost and hull in the steering gear room and the earth resistance is to be less than 0.02Ω.

7.8.7 The earthing device of propeller consists of conducting ring, brush, brush-holder and support and it is to be fitted in a dry and non-greasy position of main engine shaft where observation and maintenance is easy. After installation, the potential difference between propeller and hull is to be less than 0.1 V.

7.8.8 The sealing device of cable penetrating shell plate is to be so arranged to be enclosed in a small separating room (in the engine room or void spaces as far as practicable) and the cable connecting to anode is not to pass through the oil tank which is loaded with low flash point oil. Where the cable passes through the cofferdam or clean ballast tank of oil tankers, it is to be enclosed in a solid steel pipe with the thickness not less than 10 mm. Watertight electrical conduits or water-proof cables are to be provided in water tanks.

7.9 Inspection of cathodic protective system

7.9.1 After the installation of cathodic protective system, the various installed electrodes are to be inspected (sacrificial anode, auxiliary anode and reference electrode). The number, type and installation position are to be in compliance with the arrangement of sacrificial anode and/or arrangement of impressed current cathodic protection.

7.9.2 The surface of various electrodes is to be inspected. No cracks or dirt is to be on the surface.

7.9.3 For the sacrificial anode fixed by welding, quality of weld is to be inspected and for the sacrificial anode fixed by bolt, it is to be confirmed that loose-proof device is used for fixing and the electrical connection is reliable.

7.9.4 The electrical connection between devices used for impressed current cathodic protective system is to be reliable. The earthing of rudder and propeller is to meet the relevant requirements of 7.8.6 and 7.8.7 of the Guidelines.

7.9.5 The connecting cable between auxiliary anode and reference anode is to be properly protected and fixed reliably.

7.9.6 Effectiveness test is to be carried out for the impressed current cathodic protective system during the trial. The measured protective potential values are to be in compliance with the requirements of calculations for cathodic protective design.

CHAPTER 8 MAINTENANCE AND REPAIR OF ANTICORROSIVE SYSTEM

8.1 General requirements

8.1.1 This Chapter applies to the inspection, maintenance and repair of anticorrosive system for the ships in service. The repair of coating defects during coating application may be carried out by reference to it.

8.1.2 The condition inspection for the effectiveness of anticorrosive system is to be carried out for ships within the required period in accordance with the relevant requirements of CCS rules.

8.1.3 During repair and maintenance of the coating, where relevant CTF is carried on board, the repair is to be carried out in accordance with the CTF. Where no relevant CTF is available, new paint's compatibility with the original coating is to be considered and CTF of the new coating is to be submitted at the same time. In order to be convenient for maintenance and repair of anticorrosive system, the shipowner or owner is to supply the relevant design documents of original anticorrosive system to the repairing yard as far as possible.

8.1.4 Where the repair or re-coating is carried out, or change is made for the design of original anticorrosive system, the new design documents and construction technology are to be submitted to CCS for approval. After completion, the manufacturer is to supply the completion documents to the owner for information.

8.1.5 For ships with class notations for coatings, in-service maintenance, repair and partial re-coating activities are to be recorded in the coating technical files. If a full re-coating is carried out, the items specified in 5.2.4 of the Guidelines are to be recorded in the Coating Technical File.

8.1.6 The coatings for specific spaces applying for class notations are at least to be in FAIR condition.

8.1.7 For the repair of coating in positions which are required by the Rules, the surface cleaning and final coating in these positions are to be inspected and confirmed by the coating inspector.

8.2 Inspection of coating

8.2.1 Prior to the inspection of coating condition, the surface intended to be inspected is to be cleaned. In general, high-pressure water is to be used to wash the dust, sludge, attached marine organism, etc. on the structural surface, where necessary, mechanical tool may be used for cleaning.

8.2.2 During the inspection of coatings for general spaces, corrosion condition is to be assessed by means of the relevant defect coefficient calculated in accordance with Appendix E.

8.2.3 During the inspection of coatings for specific spaces, they may be divided into several zones in accordance with the following table for condition assessment. The assessment of other positions may be carried out by means of the method. The coating conditions are categorized as "GOOD", "FAIR" and "POOR".

Coating conditions **Table 8.2.3**

	GOOD	FAIR	POOR
Breakdown of coating or area rusted (1)	＜ 3%(only spot rusting) (3)	3 – 20 %	＞ 20 %
Area of hard rust scale (1)	-	＜ 10 %	⩾ 10 %
Local breakdown of coating or rust on edges or weld lines (2)	＜ 20 %	20 – 50 %	＞ 50 %
Notes: (1) % is the percentage of the area under consideration. (2) % is the percentage of edges or weld lines in the area under consideration. (3) Spot rusting i.e. rusting in spot without visible failure of coating.			

8.2.4 Visual inspection is to be carried out for coating condition by naked eyes. Attention is to be paid to the coating condition of the following positions:

(1) structural positions where water is easily accumulated;

(2) the interior of tanks;

(3) zones adjacent to auxiliary anode for impressed current protective device;

(4) other zones which easily cause coating damage during the service.

8.2.5 Local maintenance, repairing, renewing or full re-coating may be carried out in accordance with the damage extent of coating where:

(1) larger areas of coating surface are attached with marine organisms under waterline;

(2) larger areas of corrosion appear on the structural surface; or area of individual rust is larger;

(3) obvious flaking, breakdown, crack or aging appears on the coating;

(4) wear, damage or pull appears on the coating during the service;

(5) defects affecting coating performance, such as flowing, shrinkage, crack, blowhole, interlayer peeling or chalking on the coating, etc. appear during the coating application.

8.3 Surface preparation prior to repair of coating

8.3.1 Where it is necessary to repair the coating of shell plate of the ship, the water in the tanks is to be discharged after the ship is in dock, in order to prevent the shell plate from being dewed. Meanwhile in order to prevent the shell plate from being polluted by water discharged from the drain hole, it is to be plugged by a treenail or a temporary scupper pipe is to be provided.

8.3.2 Prior to repair of coating application, surface preparation is to be carried out by power tool grinding, ultra-high-pressure water-jetting (having pressure of 70 MPa or higher) or blasting method in accordance with the coating damage types and extents. The primer coat is to be applied as soon as possible after surface preparation to avoid re-rusting of steel.

8.3.3 Where the shell plate is cleaned by blasting and high pressure water, the anode, reference electrode and anodic shield are to be carefully protected to prevent damages.

8.3.4 If the zones are determined where the original coating can be partially kept and recoated, more complete roughing treatment is to be carried out by the method of sand stripping or power tool grinding.

8.3.5 Where local de-rusting is carried out or damaged coating is removed, slope-type roughing treatment is to be carried out by power tool within the range of 50 to 100 mm around the circumference of de-rusting zone in accordance with the coating thickness and the requirement of Fig. 8.3.5.

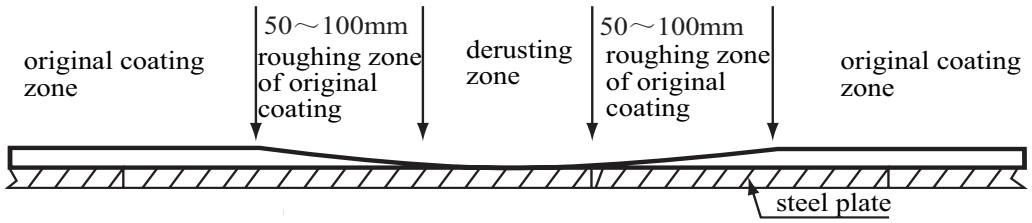


Fig.8.3.5 Diagram of Roughing Treatment

8.3.6 Prior to coating application, the repair of coating for general spaces is to be carried out in accordance with Appendix E, choosing the appropriate surface preparation method according to different values of defect equivalence.

8.3.7 Prior to coating application and for the repair of coating for specific spaces, the surface to be coated is to be kept clean and the surface condition is to comply with the requirements of Table 8.3.7.

Requirements for the condition of surface to be coated Table 8.3.7

Coating condition	GOOD	FAIR	POOR
Preparation	Removal of mud, oil, grease, etc., fresh-water hosing, drying; appropriate means of protection is to be taken for intact coating next to damaged area.		
Method	Grinding	Grinding or blasting	Blasting
Surface cleanliness	St3 or according to manufacturer's recommendation	St3 or Sa 2½	Sa 2½
Surface salt	Not more than 80 mg/m^2 (not more than 120 mg/m^2 for void spaces)		
Surface temperature	The surface temperature of steel is more than 3℃ above the dew point		
Surface profile	According to CTF or manufacturer's recommendation		

8.4 Repair of coating

8.4.1 The type of paint for repair is to assort with the original coating system. The owner and the manufacturer are to confirm the new coating's compatibility with original coating.

8.4.2 Where bare steel plate appears after cleaning, one layer of primer coat which is consistent with the coating system around is to be coated in time in the bare position.

8.4.3 The coating application technology for the paint for repair may be referred to the relevant requirements of Chapter 4 or Chapter 5 of the Guidelines.

8.4.4 For the cargo tanks loaded with oil product or chemicals, the repair of coating is to be carried out in accordance with the method suggested by the manufacturer.

8.4.5 For the repair of coating for specific spaces in accordance with Chapter 5, the following repair work is to be carried out in accordance with the coating conditions as specified in 8.2.3 and different target useful life. The repair of permanent means of access for inspection in the above positions may be carried out in accordance with Table 8.4.5.

Requirements for coatings **Table 8.4.5**

Assessment of coating conditions	Coating system	Dry film thickness (DFT)
GOOD	Epoxy-based coating systems furnished with CCS product approval certificate or according to manufacturer's recommendation	Medium term (10 year target life): 250 μm DFT Minimum two spray coats with two stripe coats Long term (more than10 years' target life): 320 μm DFT Minimum two spray coats with two stripe coats
FAIR		
POOR		

8.4.6 Visual inspection and film thickness measurement are to be carried out in the repaired zones in accordance with the requirements after the coating is repaired. The appearance and film thickness of coating are to be in compliance with the design requirements for repair of coating application.

8.5 Inspection of cathodic protective devices

8.5.1 After the cathodic protective system of ships is put into service, the effect of cathodic protection is to be inspected periodically. The following methods may be used to measure and assess the effect of the cathodic protection:

(1) the potential of protected members is to be measured. The potential of protected members is to be in compliance with the requirements of the calculations for cathodic protective design;

(2) visual inspection is to be carried out, docking inspection or visual inspection under water by the diver.

8.5.2 After the cathodic protective system is delivered, the reliability of its operation is to be inspected periodically:

(1) for sacrificial anodic protective system, dissolution of anode, mechanical damage, etc. are to be inspected. In general, such inspection is carried out during dock repairing;

(2) for impressed current cathodic protective system, the operation of electrical equipment e.g. output current (including current of each auxiliary anode branch) and protective potential, etc., working condition of auxiliary anode, cable and reference electrode are to be inspected during the dock repairing.

8.5.3 Where the following are found, cathodic protective system is to be maintained:

(1) the anode or electrode which is the same or similar to the original design is to be selected for installation if sacrificial anode, auxiliary anode and reference electrode drop during the service;

(2) the sacrificial anode is to be renewed if it is seriously corroded and passivated, and cannot maintain the protective effect before the next dock repairing;

(3) the fixed devices of sacrificial anode, auxiliary anode and reference electrode are to be refixed if the devices are corroded obviously or loosen;

(4) the auxiliary anode is to be renewed if it exceeds the required service life, or the reference electrode is to be renewed if it loses its accuracy;

(5) the power supply device of impressed current protective system is to be repaired or renewed if the output is not in order.

APPENDIX A EXAMPLE OF DAILY LOG AND NON-CONFORMITY REPORT

DAILY LOG Sheet No:

Ship: **Tank/Hold No:** **Database:**									
Part of structure:									
SURFACE PREPARATION									
Method: **Area (m^2):** **Abrasive:** **Grain size:** **Surface temperature:** **Air temperature:** **Relative humidity (max):** **Dew point:** **Standard achieved:** **Rounding of edges:**									
Comments:									
Job No.: **Date:** **Signature:**									
COATING APPLICATION: **Method:**									
Coat No.	**System**	**Batch No.**	**Date**	**Air t emp.**	**Surf temp.**	**RH%**	**Dew point**	**DFT* Meas.***	**Specified**
*** Measured minimum and maximum DFT. DFT readings to be attached to daily log**									
Comments:									
Job No: **Date:** **Signature:**									

DAILY LOG Sheet No:

Ship:	**Tank/Hold No:**	**Database:**
Part of structure:		
DESCRIPTION OF THE INSPECTION FINDINGS TO BE CORRECTED		
Description of findings:		
Reference document (daily log):		
Action taken:		
Job No.:	**Date:**	**Signature:**

APPENDIX B DRY FILM THICKNESS MEASUREMENTS

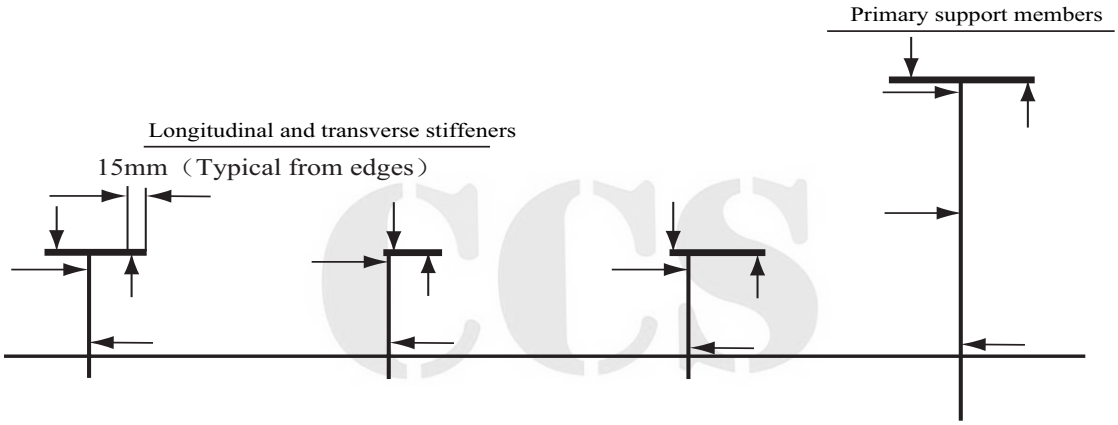
The following verification check points of DFT are to be taken:

.1 one gauge reading per 5 m2 of flat surface areas;

.2 one gauge reading at 2 to 3 m intervals and as close as possible to tank boundaries, but not further than 15 mm from edges of tank boundaries;

.3 longitudinal and transverse stiffener members:

One set of gauge readings as shown below, taken at 2 to 3 m run and not less than two sets between primary support members;



Note: Arrows of diagram indicate critical areas and are to be understood to mean indication for both sides.

Figure 1

.4 3 gauge readings for each set of primary support members and 2 gauge readings for each set of other members as indicated by the arrows in the diagram;

.5 for primary support members (girders and transverses) one set of gauge readings for 2 to 3 m run as shown in figure 1 above but not less than three sets;

.6 around openings one gauge reading from each side of the opening;

.7 five gauge readings per square metre (m^2) but not less than three gauge readings taken at complex areas (i.e., large brackets of primary support members); and

.8 additional spot checks are to be taken to verify coating thickness for any area considered necessary by the coating inspector.

APPENDIX C CALCULATION OF SACRIFICIAL ANODIC PROTECTION

C1 In general, the generating current capacity of sacrificial anode may be obtained from the relevant standard. For these anodes with special specification or special design, the generating current capacity I_f is calculated by the following formula:

$$I_f = \frac{\Delta E}{R} \times 1000 \qquad \text{mA}$$

where: I_f —— the generating current capacity of sacrificial anode, in mA;
ΔE—— drive potential of sacrificial anode, in V; 0.20 for zinc alloy anode or according to the product nominal value of the manufacturer; 0.25 for aluminum alloy anode or according to the product nominal value of the manufacturer;
R —— water contact resistance of sacrificial anode, in Ω.

C2 The water contact resistance is to be calculated in accordance with the different anodic shapes and different methods.

C2.1 For the long slender-shaped anode not in contact with the protected object, where $L \geqslant 4r$, the water contact resistance R may be calculated as following:

$$R = \frac{\rho}{2\pi L}(\ln\frac{4L}{r} - 1) \qquad \Omega$$

For the short slender-shaped anode not in contact with the protected object, where $L < 4r$, the water contact resistance R may be calculated as following:

$$R = \frac{\rho}{2 \cdot \pi L}\left[\ln\left\{\frac{2L}{r}\left(1+\sqrt{1+\left(\frac{r}{2L}\right)^2}\right)\right\} + \frac{r}{2L} - \sqrt{1+\left(\frac{r}{2L}\right)^2}\right] \qquad \Omega$$

Note: The two formulae above are applicable to the condition where the distance between the anode and the surface of the protected object is not less than 30 cm. Where the distance between the anode and the surface of the protected object is within 15-30 cm, the coefficient of correction 1.3 is to be applied to the formulae, i.e. the calculation results obtained from the formulae multiplied by 1.3.

where: ρ —— seawater resistivity, in Ω·cm, generally taken as 25;
L —— length of sacrificial anode, in cm;
r —— equivalent radius of sacrificial anode, in cm, it may be obtained as following:

$$r = \frac{C}{2\pi} \qquad \text{cm}$$

where: C —— circumference of cross-section for sacrificial anode, in cm.

C2.2 For the long flush-shaped anode (the ratio of length to width or thickness is to be 1 and above) installed against the protected object, the water contact resistance R may be calculated as following:

$$R = \frac{\rho}{2S} \qquad \Omega$$

where: ρ —— seawater resistivity, in Ω·cm, generally taken as 25;
S —— equivalent length of sacrificial anode, in cm; it may be obtained as following:

$$S = \frac{L + B}{2} \quad \text{cm}$$

where: L —— length of sacrificial anode, in cm;
B —— breadth of sacrificial anode, in cm.

C2.3 For the short flush-shaped anode of other size or bracelet sacrificial anode installed against the protected object, the water contact resistance R may be calculated as following:

$$R = \frac{0.315\rho}{\sqrt{A}} \quad \Omega$$

where: ρ —— seawater resistivity, in Ω·cm, generally taken as 25;
A —— exposed area of sacrificial anode, in cm^2.

C3 For the selection of type of anode, the service life of individual anode may be checked as following:

$$t = \frac{m * Q * 1000 * K}{I_m * 8760 * p} \quad \text{Y}$$

where: t —— service life of sacrificial anode, in Y;
m —— mass of individual sacrificial anode, in kg;
Q —— actual capacity of sacrificial anode, in Ah/kg;
I_m —— mean generating current capacity of sacrificial anode, in mA. (0.5～0.55) I_f for offshore installations with longer protection period; (0.6～0.7) I_f for general ships;
K —— coefficient of utilization, taken from Table C1;
p —— ballast ratio, 100% for the structure submersed in the liquid for a long period, 50%～60% for ballast tank, or according to actual design.

Coefficient of utilization of sacrificial anode **Table C1**

Type of sacrificial anode	Coefficient of utilization of sacrificial anode
Long slender-shaped anode not in contact with the protected object, where $L \geqslant 4r$	0.90
Short slender-shaped anode not in contact with the protected object, where $L < 4r$	0.85
Long flush-shaped anode (the ratio of length to width or thickness is to be 1 and above) installed against the protected object	0.85
Short flush-shaped anode of other size or bracelet sacrificial anode installed against the protected object	0.80

C4 The total mass of sacrificial anode may be calculated as following:

$$M_z = \frac{I_i * S_i * t * 8760 * p}{K * Q * 1000} \quad \text{kg}$$

where: t —— service life of sacrificial anode, in Y;

M_z —— total mass of sacrificial anode, in kg;
Q —— actual capacity of sacrificial anode, in Ah/kg;
I_i —— protective current density as required, in mA/m^2, see Table 7.1.4;
S_i —— area of the protected positions, in m^2;
K —— coefficient of utilization, taken from Table C1;
p —— ballast ratio, 100% for the structure submersed in the liquid for a long period, 50%～60% for ballast tank or according to actual design.

C5 The number of sacrificial anodes may be calculated as following:

$$N_1 = \frac{I_i S_i}{I_m} \quad \text{piece}$$

where: N_1 —— number of anodes for the protected position;
I_i —— protective current density as required, in mA/m^2;
S_i —— area of the protected positions, in m^2;
I_m —— mean generating current capacity of sacrificial anode, in mA. (0.5～0.55) I_f for offshore installations with longer protection period; (0.6～0.7) I_f for general ships;
I_f —— the generating current capacity of sacrificial anode, in mA.

$$N_2 = \frac{M_z}{m} \quad \text{piece}$$

where: N_2 —— number of anodes for the protected position;
M_z —— total mass of sacrificial anode, in kg;
m —— mass of individual sacrificial anode, in kg;

The selected number of anodes is the larger value of $N_1$and N_2.

If several positions are protected, the number of sacrificial anodes for each position is to be calculated respectively as above.

APPENDIX D CALCULATION OF IMPRESSED CURRENT CATHODIC PROTECTION

D1 Area of submerged hull

D1.1 Accurate calculation according to the ship body lines plan

D1.2 The area of submerged hull may be calculated as following:

$$S_1 = 1.7TL_{wJ} + \nabla/T$$

where: S_1—— area of submerged hull, in m^2;
T—— full load draughts, in m;
L_{wJ}—— load waterline length, in m;
∇—— volume of displacement of full load, in m^3.

D2 The surface area of propellers may be calculated as following:

$$S_2 = \frac{\pi * n}{2} d_1^2 \eta + n\pi d_2 L$$

where: S_2—— surface area of propellers, in m^2;
n —— number of propellers;
d_1—— diameter of propellers, in m;
η—— developed area ratio of propellers;
d_2—— boss diameter, in m;
L—— boss length, in m.

D3 For rudder and other appendage, areas S_3 and S_4 are calculated according to the actual size respectively.

D4 The protective current density is related to factors such as material quality of hull, condition of surface coating, sailing factor, service speed, dry-docking interval and condition of water quality. During design, the protective current density is generally selected according to Table 7.1.4. The protective current density may be increased appropriately for special ships subject to the operating conditions and dry-docking interval.

D5 The total protective current necessary for the ship may be calculated as following:

$$I = i_1 * S_1 + i_2 * S_2 + i_3 * S_3 + i_4 * S_4$$

where: I—— the total protective current necessary for the ship, in A;
i_1—— protective current density of the hull, in A/m^2;
i_2—— protective current density of the propeller, in A/m^2;
i_3—— protective current density of the rudder, in A/m^2;
i_4—— protective current density of other appendage, in A/m^2;
S_3——area of the rudder;
S_4——area of other appendage.

APPENDIX E DEFECT ASSESSMENT OF ORIGINAL COATING AND SELECTION OF SURFACE TREATMENT METHODS

E1 Defect assessment of original coating

For coatings without class notations, prior to repair coating application, the coating defects may be assessed in accordance with the damage type, extent and range of original coating. The coating defect extent is showed by defect equivalence Q:

$$Q = \Sigma(F_i \times S_i)$$

where: Q —— defect equivalence, it is 0 to 25;
F_i —— defect coefficient showing damage type and extent, refer to Table E1;
S_i —— area coefficient, the ratio of defect to the assessed area, refer to Table E2.

Defect coefficient F_i **Table E1**

Defect type Defect coefficient	Corrosion	Flaking, mm		Crack	Peeling
		Finish paint	Primer coat		
1		$<\phi 1$		Shallow crack of coating surface	
2		$<\phi 3$			Only small piece of peeling on finish paint
3	Thin rust	$<\phi 5$	$<\phi 1$	Deeper crack where the primer coat can be seen	Only big piece of peeling on finish paint
4		$\geqslant\phi 5$	$<\phi 3$		Interlayer peeling of primer coat
5	Thick rust		$\geqslant\phi 3$	Deep crack where the coated surface can be seen	Peeling in big pieces on the coated surface

Area coefficient S_i **Table E2**

Area coefficient S_i	Ratio of defect to the assessed area
1	≤5%
2	>5%～≤15%
3	>15%～≤30%
4	>30%～≤50%
5	>50%～≤100%

E2 Selection of surface treatment methods

According to the assessed defect equivalence, suitable surface treatment methods are to be selected in accordance with the recommendation of Table E3.

Selection of surface treatment methods **Table E3**

Defect equivalence		Surface treatment method	Condition of the treated surface
Epoxy and modified epoxy paint	Oil, chlorinated rubber, ethene paint		
Above 20	Above 40 (above 20 for one defect)	Spray cleaning	To completely remove the original coating and corrosion to bare the metal color (above Sa2 grade)
10 ～ 19	25 ～ 39 (above 15 for one defect)	Spray cleaning or spray stripping	To keep the completely attached original coating, and completely remove the corrosion and unsecured attached original coating (Sa2 grade)
5 ～ 9	13 ～ 24 (above 10 for one defect)	Spray stripping or power tool grinding	To keep the completely attached original coating, and completely remove the corrosion and unsecured attached original coating (St3 grade or Sa2 grade)
Below 4	5 ～ 12	Power tool grinding	To remove the corrosion and unsecured attached original coating and keep the others (St2 ～ 3 grade)
	Below 4	Both by scraper or wire brush	To remove the unsecured attached original coating and keep the others (St2 grade)

APPENDIX F CROSS-REFERENCE TABLE BETWEEN ISO STANDARDS AND GB STANDARDS

To facilitate the application of the Guidelines in China, the cross-reference table (refer to Table F1) between ISO standards referred to in the Guidelines and related GB standards is developed. As the relevant standards referred to in the Guidelines are mandatory, the GB standards in Table F1 are only for reference.

Cross-reference table between ISO standards and GB standards Table F1

ISO standards	GB standards
ISO 8501-1:1988 Preparation of steel substrates before application of paints and related products -- Visual assessment of surface cleanliness	GB 8923-1988 Rust grades and preparation grades of steel surfaces before application of paints and related products
ISO 8503-1:1988 Preparation of steel substrates before application of paints and related products -- Surface roughness characteristics of blast-cleaned steel substrates	GB/T 13288.1-2008 Preparation of steel substrates before application of paints and related products -- Surface roughness characteristics of blast-cleaned steel substrates
ISO 8503-2:1988 Preparation of steel substrates before application of paints and related products -- Surface roughness characteristics of blast-cleaned steel substrates -- Part 2: Method for the grading of surface profile of abrasive blast-cleaned steel -- Comparator procedure	GB/T 13288-1991 The assessment of profile grades of steel surface before application of paint and related products—Comparator
ISO 8502-6 Preparation of steel substrates before application of paints and related products -- Tests for the assessment of surface cleanliness -- Part 6: Extraction of soluble contaminants for analysis -- The Bresle method	GB/T 18570.6-2005 Preparation of steel substrates before application of paints and related products -- Tests for the assessment of surface cleanliness -- Part 6: Extraction of soluble contaminants for analysis -- The Bresle method
ISO 8502-9:1998 Preparation of steel substrates before application of paints and related products -- Tests for the assessment of surface cleanliness -- Part 9: Field method for the conductometric determination of water-soluble salts	GB/T 18570.9-2005 Preparation of steel substrates before application of paints and related products -- Tests for the assessment of surface cleanliness -- Part 9: Field method for the conductometric determination of water-soluble salts
ISO8502-3:1993 Preparation of steel substrates before application of paints and related products -- Tests for the assessment of surface cleanliness -- Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)	GB/T 18570.3-2005 Preparation of steel substrates before application of paints and related products -- Tests for the assessment of surface cleanliness -- Part 3: Assessment of dust on steel surfaces prepared for painting (pressure-sensitive tape method)