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GUIDELINES FOR SURVEY OF CORROSION RESISTANT STEEL OF CARGO OIL TANKS IN CRUDE OIL TANKERS

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CONTENTS

CHAPTER 1 GENERAL

1.1 Purpose

1.1.1 The purpose of the Guidelines is to ensure that the structure of cargo oil tanks of crude oil tankers complies with the requirements of IMO MSC.289(87), using corrosion resistant steel as an alternative means of protection to improve corrosion resistance performance and achieve the target useful life.

1.1.2 The capability of corrosion resistant steel to achieve its target useful life depends on the type, use and maintenance of steel. The Guidelines are intended to provide the requirements for confirmation of the mechanical property and corrosion resistance performance of hull structural steels, the limitation of use, their control during construction of ships and their in-service maintenance in order to ensure the safety of structural members of cargo oil tanks in crude oil tankers during the target useful life.

1.2 Application

1.2.1 The Guidelines apply to crude oil tankers of 5,000 DWT and above.

1.2.2 The Guidelines apply to normal and higher strength hull structural steel plates, flats, sections and bars with thicknesses not more than 50 mm as specified for hull structural steels in CCS Rules for Materials and Welding.

1.2.3 In addition to the Guidelines, the corrosion resistant steel of cargo oil tanks in crude oil tankers are to meet the relevant requirements for hull structural steels in Chapter 3, PART ONE of CCS Rules for Materials and Welding.

1.2.4 The corrosion resistant steel referred to in the Guidelines is applicable to crude oil tanker structure specified in the performance standards of IMO resolution MSC.289(87). However, it may be referred to in the structures having the ambient conditions similar to those of cargo oil tanks in crude oil tankers.

1.3 Terms and Definitions

1.3.1 The terms and definitions used in the Guidelines are as follows:

(1) *Crude oil tanker* means a crude oil tanker defined in Regulation 1 of Annex I of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto, refer to the crude oil tankers and crude oil/product oil carriers engaged in the trade of carrying crude oil in compliance with 1.1 of the International Oil Pollution Prevention Certificate (IOPP Certificate Form B).

(2) *Corrosion resistant steel of cargo oil tanks in crude oil tankers* (hereinafter referred to as corrosion resistant steel) means the structural steel whose corrosion resistance performance in the bottom or top of the internal cargo oil tank is tested and approved to satisfy the requirements for structural steels in IMO MSC.289(87) in addition to other relevant requirements for ship's material, structural strength and construction, comparing with the normal and higher strength hull structural steels in CCS Rules for Materials and Welding.

(3) *Target useful life* means the target value, in years, of the durability of a structure for which the means of corrosion protection or utilization of corrosion resistance material is designed. Normally, the target useful life of crude oil tankers, for which corrosion resistant steel is used as the structural material, is 25 years.

(4) *Conventional hull structural steel* (hereinafter referred to as conventional steel) means the hull structural steels listed in Section 2 Normal Strength Hull Structural Steels and Section 3 Higher Strength Hull Structural Steels, Chapter 3, PART ONE of CCS Rules for Materials and Welding.

(5) *Reference steel* means the conventional steel with the chemical composition of ladle samples meeting the requirements of Table A1 in Appendix A of the Guidelines, which is used as a reference test piece in the corrosion test.

(6) *Upper deck corrosion test* means a test to verify the corrosion resistance performance of steels used in upper deck areas of cargo oil tanks in crude oil tankers.

(7) *Inner bottom plating corrosion test* means a test to verify the corrosion resistance performance of steels used in inner bottom plating areas of (double bottom) cargo oil tanks in crude oil tankers.

(8) *Parent steel grade* means the corrosion resistant steel grade with the mechanical properties corresponding to those listed in Section 2 Normal Strength Hull Structural Steels and Section 3 Higher Strength Hull Structural Steels, Chapter 3, PART ONE of CCS Rules for Materials and Welding.

1.4 Test and Inspection

1.4.1 The manufacturer is to afford the Surveyor all necessary facilities and access to all relevant parts of the works to enable him to verify that the approved process is adhered to, for selection of test materials and the witnessing of tests and for verifying the precision of the testing equipment.

1.4.2 All corrosion tests are to be carried out by qualified personnel using test devices complying with requirements and according to specified test procedures at the laboratories meeting CCS approval requirements for corrosion test organizations (for requirements, refer to Appendix B of the Guidelines).

CHAPTER 2 WORKS APPROVAL FOR CORROSION RESISTANT STEEL

2.1 General Requirements

2.1.1 The manufacturer producing corrosion resistant steel is to submit an application to CCS for approval.

2.1.2 The corrosion resistant steels may be works approved individually according to the areas of application (see Figure 5.2.1):

(1) lower surface of upper deck of cargo oil tank and its surrounding structures;

(2) upper surface of inner bottom plating of cargo oil tank and its surrounding structures;

(3) structures of both above (1) and (2) locations.

2.1.3 In addition to the corrosion test specified in the Guidelines, the works approval of corrosion resistant steel is to be carried out in accordance with the relevant requirements of W01 Rolled Steel of CCS Guidelines for Survey of Marine Products.

2.1.4 The corrosion tests are to be carried out individually based on the areas of application in accordance with the requirements of Chapter 4 of the Guidelines. The assessment criteria are to meet the relevant requirements of the Appendix of the Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers in IMO MSC.289(87) (see also Appendix A of the Guidelines).

2.1.5 Where the original approval scope is changed (non-parent material, such as welding consumables), relevant corrosion test is to be carried out to verify the factors causing such change in accordance with the requirements of the Guidelines.

2.2 Steel Manufacturing

2.2.1 The corrosion resistant steel is to be manufactured by electric or basic oxygen process or other methods specially approved by CCS, and is to be in compliance with the relevant requirements of Section 1, Chapter 3, PART ONE of CCS Rules for Materials and Welding.

2.2.2 The deoxidation and rolling for each grade of corrosion resistant steels and their condition of supply are to meet the relevant requirements of Section 2 or Section 3, Chapter 3, PART ONE of CCS Rules for Materials and Welding.

2.2.3 The steel is to be reasonably free from segregations and non-metallic inclusions. The finished material is to have a workmanlike finish and is to be demonstrated as being free from internal and surface defects prejudicial to the use of the material for the intended application. The acceptance criteria for surface finish and procedures for the repair of defects are to meet the relevant requirements of Section 1, Chapter 3, PART ONE of CCS Rules for Materials and Welding.

2.2.4 The allowable thickness tolerances of corrosion resistant steel plates, flats and sections used for hull structures are to meet the relevant requirements of 3.1.3, Section 1, Chapter 3, PART ONE of CCS Rules for Materials and Welding. Corrosion resistant steel used for other purposes may be in accordance with the requirements of order contract.

2.3 Application for Approval and Test Program

2.3.1 When a steel manufacturer applies for works approval, following information is to be submitted, in addition to the necessary information normally to be submitted for approval:

(1) A corrosion test program, details of test equipment and test environment;

(2) Technical data related to acceptance criteria, for confirming corrosion resistance;

(3) Product test procedures and acceptance criteria;

(4) The technical background explaining how the variation in added and controlled elements improves corrosion resistance: a relationship of all the chemical elements which affect the corrosion resistance of steel; the chemical elements added/controlled to achieve the required level of corrosion resistance are to be specifically verified for acceptance. Verification is to be based on the ladle analysis of the steel;

(5) The grade and maximum specification of corrosion resistant steel for which approval is requested;

(6) The application scope and relevant identification of corrosion resistant steel for which approval is requested;

(7) The applicable welding methods, welding consumables and relevant welding parameters.

2.3.2 CCS is to examine the test program and determine test requirements in accordance with the requested scope of approval. The inspections and tests to be witnessed by the Surveyor are to be confirmed in the test program. In addition to all tests necessary for conventional hull structural steels, the test items are to include the corrosion test specified in Chapter 4 of the Guidelines.

2.4 Approval Procedures

2.4.1 The corrosion resistant steels are to be approved according to their grades, conditions of supply and application areas respectively.

2.4.2 Normally, CCS Surveyor is to be present at specified stages to witness the relevant test items as required in the test program.

2.5 Approval of Corrosion Resistant Steel

2.5.1 The test is to be carried out according to the test program approved by CCS.

2.5.2 The number of casts and test samples selected are to be sufficient to make it possible to confirm the validity of interaction effects and/or the control range (upper limit, lower limit) of the elements which are added or intentionally controlled, for improving the corrosion resistance. Where agreed, this may be supported with data submitted by the manufacturer.

2.5.3 The corrosion test is to be in accordance with the requirements of Chapter 4 and Appendix A (Appendix of Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers (MSC.289 (87)) of the Guidelines.

2.5.4 For approval of corrosion resistant steels, the corrosion test is to cover welding joints using proper welding consumables, in addition to parent material.

2.5.5 In addition to the test requirements specified above, CCS may, while checking the test program, require additional tests aiming at, but not limited to, following cases:

(1) when CCS determines that the control range is set by the theoretical analysis of each element based on existing data, the number of corrosion resistance tests conducted in accordance with the Appendix to Annex of resolution MSC.289(87) is too few to adequately confirm the validity of the control range of chemical composition;

(2) When CCS determines that the data of the corrosion resistance test result obtained for setting the control range of chemical composition varies too widely;

(3) when CCS determines that the validity of the corrosion resistance test result for setting the control range of chemical composition is insufficient, or has some flaws;

(4) when CCS Surveyor has not attended the corrosion resistance tests for setting the control range of chemical composition, and CCS determines that additional testing is necessary in order to confirm the validity of the test result data; and

(5) when CCS determines that it is necessary, for reasons other than cases (1) to (4) above.

2.5.6 The chemical composition of the corrosion resistant steel is to meet the requirements for that of each corresponding grade in CCS Rules for Materials and Welding. Elements to be added for improving the corrosion resistance and for which content is beyond the scope of the Rules and not specified in the Rules are to be generally within 1% in total.

2.6 Approval Test

2.6.1 Test is to be carried out in accordance with the test program approved by CCS.

2.6.2 CCS Surveyor is to be normally present to identify the specimens at important test time according to the scheduled time as required in the test program.

2.6.3 Test results are to meet relevant requirements of paragraph 4.5 of Chapter 4.

2.6.4 After completion of the test, the manufacturer is to produce the test report and submit it to CCS.

2.7 Identification

2.7.1 According to the Guidelines, a corrosion designation is to be added after grade designation of the hull structure parent material approved as corrosion resistant steel of cargo oil tanks in crude oil tankers according to its area of application:

for upper deck area of cargo oil tanks, RCU;

for inner bottom plating area of cargo oil tanks, RCB;
for both upper deck and inner bottom plating area of cargo oil tanks, RCW.

For example, the corrosion resistant steel meeting the relevant performance requirements of DH36 grade for higher strength hull structural steel specified in CCS Rules for Materials and Welding and being suitable for use in upper deck structure inside cargo oil tank of crude oil tanker is to be designated as "DH36-RCU".

2.8 Certificate

2.8.1 Where all test results meet the relevant requirements of the Guidelines, CCS will approve the corrosion resistant steel and issue a works approval certificate.

2.8.2 The works approval certificate is to include the following:

(1) approval certificate No., name of manufacturer or trademark;

(2) name and identification;

(3) range of chemical composition of approved steel (including weight of each element added or intentionally controlled for improving corrosion resistance);

(4) specification of approved steel;

(5) steelmaking method, casting method and condition of supply;

(6) brand and welding process of applicable welding consumables; and

(7) period of validity of approval.

CHAPTER 3 PRODUCT INSPECTION FOR CORROSION RESISTANT STEEL

3.1 General Requirements

3.1.1 All corrosion resistant steels are to be manufactured at works which have been approved by CCS.

3.1.2 Unless otherwise specified in the Guidelines, the corrosion resistant steels are to be manufactured in accordance with the relevant requirements of Section 1, Chapter 3, PART ONE of CCS Rules for Materials and Welding and the approved production process.

3.1.3 The requirements for mechanical properties of corrosion resistant steel are the same as those of hull structural steel, and is to be graded in accordance with the strength and toughness specified in Section 2 and Section 3, Chapter 3, PART ONE of CCS Rules for Materials and Welding.

3.1.4 Corrosion test is not necessary during factory inspection.

3.1.5 It is the manufacturer's responsibility to assure that effective process and production controls in operation are adhered to within the manufacturing specifications. Where inadequate control leads to inferior quality of product, the manufacturer is to identify the cause and establish measures to prevent its recurrence, and issue an investigation report and submit it to CCS Surveyor for information. Where the affected product is required for further use by the manufacturer, corrosion test is to be carried out for each rolled piece to the Surveyor's satisfaction. The frequency of testing for subsequent products offered may be increased to gain confidence in the quality at the discretion of CCS.

3.1.6 Before the certificates of quality are signed by the Surveyor, the manufacturer is required to furnish him with a written declaration stating that "We hereby certify that the material has been made by an approved process and that it has been satisfactorily tested in accordance with the CCS Rules."

3.2 Chemical Composition

3.2.1 The chemical composition of samples taken from each ladle of each cast is to be analyzed by the manufacturer. The result is to meet the provisions of paragraph 2.5.6.

3.2.2 All ranges of chemical composition related to material corrosion resistance, as identified for approval, is to be strictly controlled.

3.2.3 The analysis report of chemical composition provided by the manufacturer will be accepted by CCS, however, random check may be carried out as required by the Surveyor.

3.3 Mechanical Properties

3.3.1 Mechanical properties of the corrosion resistant steels approved by CCS are to be tested in normal production in accordance with the requirements for the approved parent steel grade.

3.3.2 The test material selection, specimen preparation, number of specimens and test are to be in compliance with the relevant requirements of Chapter 2 and Chapter 3, PART ONE of CCS Rules for Materials and Welding.

3.3.3 The test results are to meet the relevant requirements for parent steel grade specified in Section 2 or Section 3, Chapter 3, PART ONE of CCS Rules for Materials and Welding.

3.4 Other Requirements

3.4.1 Where the steel with the thickness not less than 15 mm is required of Z-direction performance, the chemical analysis of ladle samples, through-thickness tensile test and ultrasonic test are also to be carried out in accordance with the requirements of Section 10, Chapter 3, PART ONE of CCS Rules for Materials and Welding.

3.4.2 If steels are ordered with ultrasonic inspection, ultrasonic test is to be carried out for the products in accordance with the requirements of order contract.

3.4.3 The manufacturer is to be responsible for surface inspection and verification of dimensions. The acceptance by CCS Surveyor does not absolve the manufacturer from this responsibility.

3.5 Retest

3.5.1 Retest and acceptance are to be carried out in accordance with the relevant requirements of Section 2, Chapter 1, PART ONE of CCS Rules for Materials and Welding, if the mechanical properties do not meet the relevant requirements.

3.6 Identification

3.6.1 The manufacturer is to adopt a system for the identification of ingots, slabs and pieces which will enable the material to be traced to its original cast. The Surveyor can be given full facilities for so tracing the material when required.

3.6.2 Every finished piece is to be clearly marked by the manufacturer in at least one place with CCS inspection mark and the following particulars:

(1) name or trade mark of the manufacturer;

(2) unified identification mark for the grade of steel, including added designation for corrosion resistant steel; if there are other added designations for steel, they may be arranged after designation of parent steel grade in the sequence of Z-direction steel, heat input applicable, corrosion resistance and condition of supply;

(3) specification;

(4) cast number and other number or abbreviation which will enable the whole steel production process to be traced;

(5) if required by the purchaser, his order number or other identification marks.

The above particulars and seal are to be encircled with paint or otherwise marked so as to be clearly legible.

3.6.3 Where a number of light materials are securely fastened together in bundles, the manufacturer may, subject to agreement of CCS, mark only the top piece of each bundle, or alternatively, a firmly fastened durable label containing the mark may be attached to each bundle.

3.6.4 In the event that any material bearing CCS inspection mark fails to comply with the requirements of mechanical test, the mark is to be completely removed by the manufacturer.

3.6.5 In addition to the manufacturer name, the certificate of conformity for steels is at least to contain the following particulars:

(1) purchaser's name and order number, and if known, the hull number for which the material is intended;

(2) identification of the cast and, where appropriate, the test specimen number;

(3) specification;

(4) identification of the grade of steel or manufacturer's brand name (with added designation for corrosion resistant steel);

(5) chemical composition from ladle analysis (for elements specified in the Rules);

(6) weight of each element added or intentionally controlled for improving corrosion resistance confirmed during approval;

(7) mechanical test results and non-destructive test results (if required);

(8) condition of supply; and

(9) quality assurance of the manufacturer.

CHAPTER 4 CORROSION TEST

4.1 General Requirements

4.1.1 This Chapter applies to test for determining the corrosion resistant capability of steel materials and their associated welding consumables under the ambient conditions for crude oil transportation and/or storage.

4.1.2 Unless otherwise specified in this Chapter, corrosion test is to be carried out in the areas where the steel is used on board the crude oil tanker in accordance with the requirements listed in the Appendix of IMO MSC.289(87) respectively (see for details Appendix A of the Guidelines).

4.2 Test Device and Material Used for Test

4.2.1 In principle, the test devices are to meet the requirements of Appendix in IMO MSC.289(87) (see also Appendix A of the Guidelines). When the upper deck test is carried out, all specimens of each material are to be located in one vessel. It is allowable to increase diameter appropriately to 390mm on the basis of Figure A2 in Appendix A of the Guidelines so as to contain 25 specimens. If further diameter increase is needed to contain more specimens, it is to be agreed by CCS.

4.2.2 The device for upper deck test is to be capable of automatic temperature controlling, measuring and recording.

4.2.3 The laboratory placing the upper deck test device is to be provided with exhaust gas treatment equipment and gas leakage alarm unit, the exhaust emission is to meet the relevant national environment protection standards. Ventilation is to be well kept in the laboratory during test.

4.2.4 The top cover of upper deck test device is to be provided with reliable specimen fixture, which will not affect the tested surface of specimen.

4.2.5 It is to be confirmed that the corrosion rate of reference steel at the test device and conditions satisfies the criteria for evaluation, before commencement of corrosion test.

4.2.6 The chemical composition of reference steel is to be based on that of ladle analysis and in compliance with the requirements of Table A1 in Appendix A of the Guidelines.

4.2.7 The gas compositions in upper deck test are to meet the requirements of 2.1.1.8 in Appendix A of the Guidelines. During the test, the following two groups of gases with different compositions are normally to be mixed with same volume to enter into the vessels:

(1) (8±2)% O_2, (26±4)% CO_2, (200±20)ppm SO_2, N_2 balance;

(2) (1,000±100) ppm H_2S and N_2 balance.

4.2.8 The solution for inner bottom plating test is to be prepared in accordance with the following requirements:

(1) Completely mixed with 1,000 ml distilled water or deionized water, 15 ml hydrochloric acid with the concentration of 6 mol/L and 113 g sodium chloride.

(2) Normally, three test solutions are to be prepared for base metal specimen and seven for welded joint specimen.

(3) Two 10 ml samples for each prepared solution are to be diluted with distilled water or deionized water. The one sample is diluted to one tenth while another to one hundredth. The acidity of diluted liquids is to be measured by calibrated pH meter at the temperature of 30°C and the value is to meet the following requirements:

2.1±0.2 for solution diluted to one tenth;

3.1±0.2 for solution diluted to one hundredth.

(4) If the acidity of liquids does not meet the requirements, the original test solution may be adjusted by hydrochloric acid solution so that the test samples after dilution may meet the requirement for above pH values.

(5) Vessels containing the prepared solutions are to be placed in a thermostatic bath at the temperature of 30℃.In order to prevent the tested solution from evaporating, vessels are to be covered by plastic film or other appropriate sealing material.

4.2.9 During the commissioning of test devices, where the calculated corrosion loss (CLc) of reference test sample for upper deck test is less than 0.05 mm, the concentration of hydrogen sulfide gas in vessels may be increased. All subsequent tests are to be carried out under such conditions.

4.3 Test Samples and Specimens

4.3.1 Steel specimens used for corrosion test may normally be taken adjacent to sampling points for mechanical test.

4.3.2 Scantlings of specimens of steel and welding consumables for corrosion test are to meet the requirements for specimen scantlings and quantity specified in IMO resolution MSC.289(87).

4.3.3 The test surface of specimen is to be close to the rolled surface, the longitudinal of specimen is to be parallel to the direction of rolling and the scantlings of specimen are to meet the requirements of Appendix A of the Guidelines.

4.3.4 The thickness of base metal for welded joint specimen may normally be reduced to about 20 mm from a single side, the material is to be taken from the same cast as that used for base metal test and they are allowed to be taken from different plates. The specimen is to be welded in the downhand position by the process and consumables to be approved for use with the base metal. The width of weld, excluding heat affected zone, is to be of 10 ~ 20 mm.

4.3.5 The rolled surface of base metal and welded joint specimen is to be retained as far as possible. But it is allowed to be machined flush with the surface of the plate. The thickness machined is not to be more than 2 mm from rolled surface (see Figure 4.3.5). For steel plating with excessive thickness, the thickness may be reduced from the back of the test surface to 5 mm ±0.5 mm by machining. Chamfering is not allowed in way of the edge of specimen. A hole with diameter of 2 mm for hanging is to be drilled in the specimen used for inner bottom plating corrosion test, and the hole edge is to be properly chamfered.

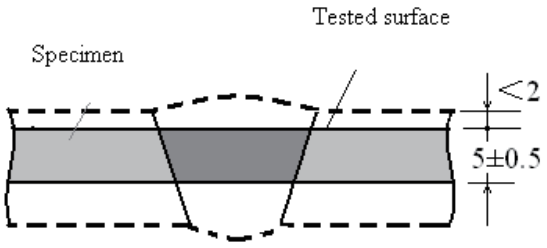

Figure 4.3.5 Sampling position of welded specimen

4.3.6 The tested surface of all specimens (including comparison specimen) is to be polished by hand with an emery paper 600 # or grinded by machine before test. Roughness of all specimens is to be almost the same. It is recommended that the roughness of polished surface reach Ra 0.16μm.

4.3.7 The scantlings of specimen may be measured accurately by micrometer or microcaliper, and the precision is 0.01 mm.

4.3.8 The specimen is to be washed by acetone and absolute ethyl alcohol in turn and dried by air blower, each specimen is to be weighed respectively and recorded. The weighing precision is 0.1 mg. Then the specimen is to be placed in dry container for use. When necessary, the specimen is to be washed by an ultrasonic cleaner or absolute ethyl alcohol and dried before test.

4.3.9 The specimen surface not to be tested for upper deck test is to be protected by coating which is capable of resisting test corrosion medium and will not affect test result.

4.3.10 All specimens are to be marked for easy identification by proper means which is easily to be identified and not to affect the test results.

4.4 Test

4.4.1 In addition to the following requirements, the upper deck test is to be carried out in accordance with the requirements of 2.1.1 in Appendix A of the Guidelines.

(1) All specimens are to be installed in place and at a basically equivalent distance to air outlet pipe (shown in Figure A2 of Appendix A of the Guidelines) before commencement of test, and each group of specimens is to be placed according to the principle of even distribution on the circumference. A certain clearance is to be kept between specimens. After the specimens are installed in place, the entire test plane is to be adjusted to horizontal position.

(2) The air inlet pipe is to be submerged in distilled water of vessel, and the end of air pipe is to be about 40 mm away from vessel bottom. In order to avoid excessive water level lowering due to water evaporation during test, distilled water is allowed to be supplemented properly to initial test position during sampling.

(3) During the test, deck temperature circulation and corrosion environment condition on board ship are to be simulated. The ambient temperature around test equipment is to be controlled as far as possible so that the temperatures of specimen and distilled water may vary in accordance with predetermined circulation requirements within the whole test period.

(4) The transition time of heating/cooling temperature means the time from the beginning of heating/cooling to the required stable temperature, see Figure 4.4.1(4)a and Figure 4.4.1(4)b. The time difference of the same transition stage (such as cooling stage, insulating stage or heating stage) is not to be more than 10 min.

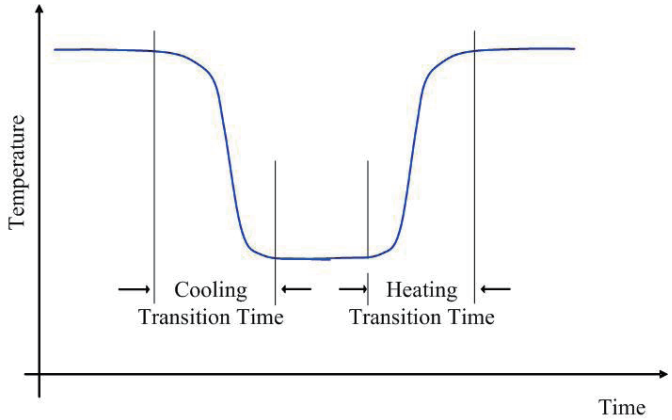

Figure 4.4.1(4)a Transition time of temperature

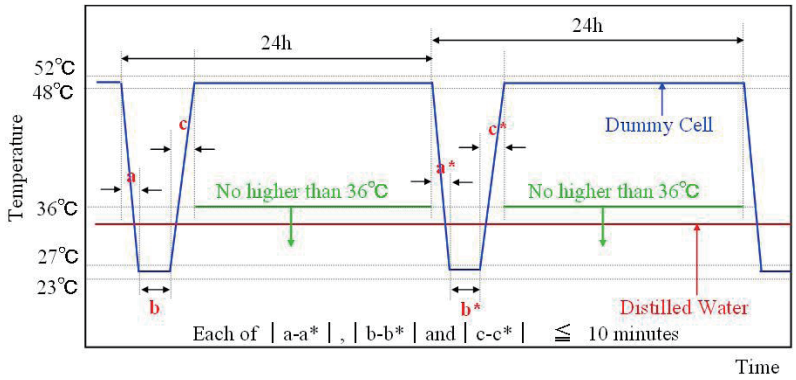

Figure 4.4.1(4)b Control of transition time

(5) During the process of test, the gases of two groups of different compositions specified in 4.2.7 are normally to be mixed with same volume, and then filled into test vessel. It is recommended that the gas flow rate within 24 h after commencement of test be controlled according to Table 4.4.1(5), and the subsequent gas flow rate is to be controlled not less than 20 ml/min.

Control of corrosive gas flow rate within 24h after commencement of test (including specimen replacement) Table 4.4.1(5)

Inner diameter of test vessel (mm)	300	390
Range of gas flow rate (ml/min)	100~110	100~170

Note: This Table is only applicable to the condition that diameter of test vessel is changed but other test conditions are the same as those specified by IMO Standards.

(6) During the whole test process, the temperatures of specimen and water are to be continuously recorded at intervals generally not exceeding 2.5 min.

(7) Where the specimen needs to be taken out/replaced during the test, corrosion gas in the test device is to be blown off by a proper amount of pure nitrogen (N_2) after test gas is shut down when the specimen is within the high temperature period, then, the specimen is to be taken out/replaced after it is dried. The time of taking out/replacing the specimen is normally not to exceed 4 h. When nitrogen is displaced, its flow rate is preferably not to be less than 300 ml/min. Normally, the test gas and flow rate are to be re-controlled in accordance with the requirements of (5) after new specimen is placed to establish the corrosion environment.

(8) The specimen is to be taken out for every stage according to the intervals required in 2.1.1.3 or 2.2.1.1 of Appendix A respectively, and the specimen is to be taken out according to the principle of even distribution.

4.4.2 In addition to the following requirements, the inner bottom plating test is to be carried out in accordance with the requirements of 2.2.1 in Appendix A of the Guidelines.

(1) When the inner bottom plating is tested, the sealing on the solution vessel is to be uncovered. The specimen with thin nylon cord is hung in the center of vessel. Each specimen may be either placed in a different vessel respectively, or several specimens of same material may be placed in one vessel. The ratio of test corrosion medium volume and specimen is not to be less than the required ratio (1 L tested solution for each specimen). Where several specimens are placed in one vessel, the interval between specimens is generally not less than 30 mm.

(2) The vessels are to be sealed during the test in order to prevent the solution from evaporating and concentrating.

(3) The specimens are to be taken out every 24 h and placed in another vessel containing a solution with the temperature of 30℃ and prepared in accordance with the requirements of 4.2.8. The solution after test is to be abandoned.

4.4.3 The specimens taken out are to be free from rust, coating and corrosive on specimen surface and weighed, as follows:

(1) The rust on the surface to be tested is to be removed by nylon brush, and the residual corrosive on the surface is to be removed by chemical method (such as solution mentioned in C3.1 of Appendix in ISO 8407-2009), then the specimen is to be washed by water and dried.

(2) For upper deck specimen, proper solutions or tools are to be applied to remove the anticorrosive painting or coating and corrosive on the test surface of specimen, then the specimen is to be washed by absolute ethyl alcohol and dried.

(3) Each dried specimen is to be weighed to the precision of 1 mg.

4.4.4 For welded joint specimen after being dried, two metallographic specimens for weld cross-section approximately 20 mm × 5 mm are to be prepared according to Figure 4.4.4. The principle axis of the metallographic specimen is to be perpendicular to the weld fusion line, and the weld fusion line is to be located approximately at its mid length. The specimens are to be mounted in resin to allow polishing of the cross section. The specimens are to be etched in Nital after polishing in order to reveal the deposited metal and base metal. The surface to be tested is to be observed by a photomicrograph with approximately 100 times magnification for evaluation. Where angle calculation is needed for evaluation, an additional photomicrograph with approximately 250 times magnification is required.

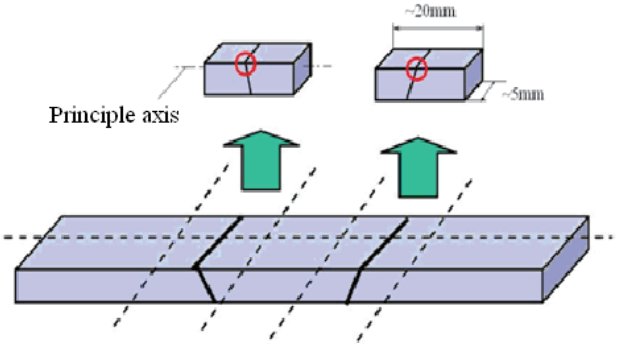

Figure 4.4.4 Metallographic sampling positions of welds

4.4.5 For welded joint specimen, the step of weld zone is to be evaluated on the metallograph by the following methods:

(1) The depth of step for weld area is to be calculated as follows:

Draw a straight line AB perpendicular to corrosion surface via the intersection of fusion line and corrosion surface; draw two parallel lines DC and EF (called as average surface lines) through line AB from upper and lower steps and extending at least 300 μm along the base metal and weld respectively, see Figure 4.4.5(1). If the intersection of the average surface line of weld and line AB is higher than that of the average surface line of base metal and line AB and if the corrosion test for base metal is satisfactory, the weld joint test is considered satisfactory. The depth R of discontinuous steps for each specimen is to be calculated by the following formula:

$$R = \frac{r \times 1000}{M} \qquad \mu m$$

where: r — measured depth of step, in mm;
M — magnification of photomicrograph.

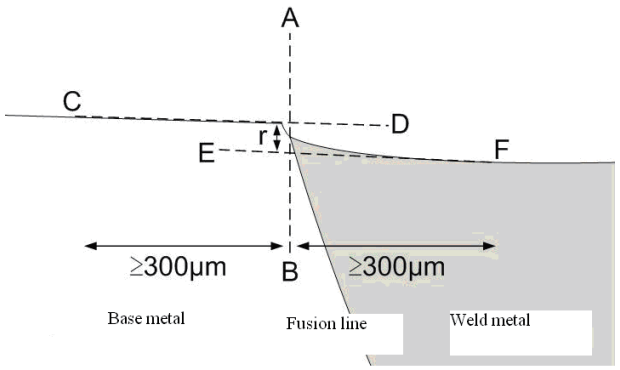

Figure 4.4.5(1) Measurement for depth of weld corrosion

(2) Measurement for angle of step according to (3) below is not necessary if the depth of step calculated on both samples is not greater than 30 μm or if either step exceeds 50 μm for a single specimen.

(3) On the photomicrograph with approximately 250 times magnification, draw two straight lines CD and EF respectively from the average surface profile of base metal and that of weld, draw a line connecting the step point at the outermost edge of base metal surface profile with the intersection of fusion line and weld surface to intersect the line CD, and measure the angle between the two lines, see Figure 4.4.5(3).

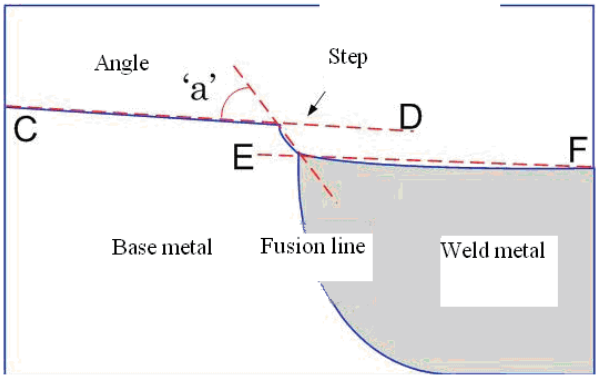

Figure 4.4.5(3) Measurement for angle of weld corrosion

4.5 Test Results and Handling

4.5.1 In addition to the following requirements of 4.5.2 to 4.5.3, the test results are to be evaluated in accordance with the requirements of 2.2.4 in Appendix A of the Guidelines.

4.5.2 The weight loss criteria for conventional steel specimens: at least 3 values of individual weight loss of 5 conventional steel specimens are to be within the following range, otherwise retest is to be carried out.

$$0.005 \times S \times D \leq W_{C\text{-}loss} \leq 0.011 \times S \times D$$

where: $W_{C\text{-}loss}$ — weight loss of single specimen, in g;

S — area of specimen to be tested, in cm^2;

D — density of steel material, in g/cm^3.

4.5.3 Calculation of corrosion reduction of corrosion resistant steel on the upper deck, ECL, is to be subject to corrosion data fit according to power function least square method.

4.5.4 Each welded specimen is to meet the following conditions, otherwise, it is regarded that the specimen contains discontinuous surface:

(1) The depth of both steps are less than or equal to 30 μm.

(2) The depth of both steps are less than or equal to 50 μm and in addition, both the measured angles are less than or equal to 15°.

4.5.5 Where the five welded specimens are considered as "without discontinuous surface", the weld corrosion test is satisfactory.

4.6 Test Record and Report

4.6.1 Relevant data of the test are to be recorded by the laboratory, at least including:

(1) measured data of original scantlings and weighing data for each specimen before test;

(2) weighing data of each specimen after test;

(3) macrophotograph of corrosion conditions on surface of specimen (including interpretations before test, before and after derusting and for special cases);

(4) parameters such as temperature of water inside vessel, specimen temperature, corrosion gas flow during the test; and

(5) signature of test recording personnel.

4.6.2 The test report is at least to include:

(1) brand (name) and compositions of test materials;

(2) dates of commencement and termination of test as well as sampling/replacing dates;

(3) test results (metallograph is necessary for weld test).

CHAPTER 5 APPLICATION OF CORROSION RESISTANT STEEL

5.1 General Requirements

5.1.1 This Chapter provides the special requirements for the use of corrosion resistant steels for cargo oil tanks in crude oil tankers during construction and service.

5.1.2 Where different anticorrosion measures are taken for different areas of the tanker, the anticorrosion measures for different areas are to be described respectively in the technical file.

5.1.3 A duplicated copy of the technical file confirmed by CCS is to be kept on board the tanker.

5.2 Ships and Areas of Application

5.2.1 Where corrosion resistant steel is used as alternative means of coating protection for cargo oil tanks of crude oil tankers to meet the requirements of SOLAS Convention, at least the approved corrosion resistant steel is to be applied in the following areas (see Figure 5.2.1):

(1) Deckhead with complete internal structure, including brackets connecting to longitudinal and transverse bulkheads. In tanks with ring frame girder construction the under deck transverse framing to be protected down to level of the first tripping bracket below the upper faceplate.

(2) Longitudinal and transverse bulkheads to be protected to the uppermost means of access level. The uppermost means of access and its supporting brackets to be fully protected.

(3) On cargo tank bulkheads without an uppermost means of access the protection to extent to 10% of the tank's height at centerline but need not extend more than 3 m down from the deck.

(4) Flat inner bottom and all structure to height of 0.3 m above inner bottom to be protected.

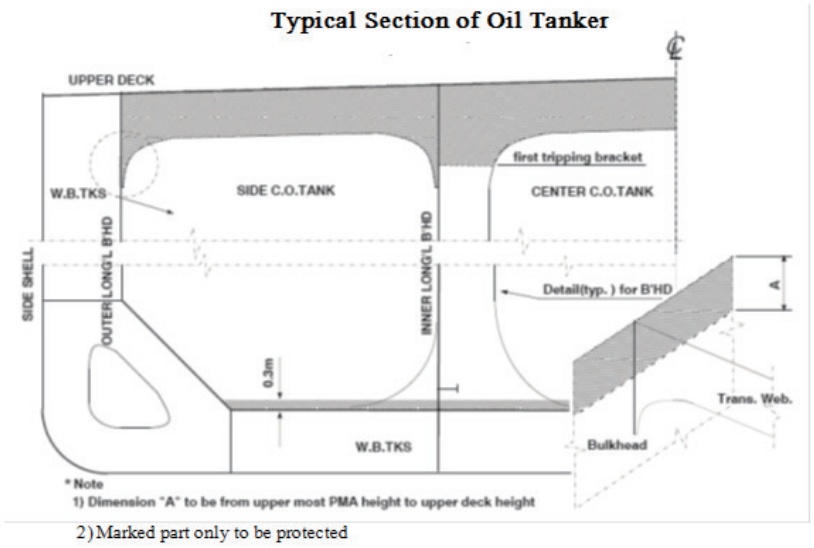

Figure 5.2.1 Scope of application of corrosion resistant steel for cargo oil tanks in crude oil tankers

5.2.2 Where the corrosion resistant steel is used for protection of the main hull structure within the range of cargo tanks specified in 5.2.1, it is recommended that the same corrosion resistant steel be used for protection of the following structures located in the same area:

(1) those portions of permanent means of access provided for inspection within the area that are not integral to the ship's structure, such as rails, independent platforms, ladders, steps, etc.;

(2) access arrangements which are integral to the ship's structure, such as increased stiffener depths for walkways, stringers, etc.;

(3) supports for piping, measuring devices, etc.

5.3 Selection of Corrosion Resistant Steel and Welding Consumables

5.3.1 Where corrosion resistant steel is used for protection of cargo oil tanks in crude oil tankers, the one approved by CCS is to be applied and the approved associated welding consumables (indicated in a certificate of steel) are to be used as far as possible by shipyards. If the welding consumables not indicated in the certificate are used, qualification of welding procedure and corrosion test are normally to be carried out in advance.

5.3.2 Different anticorrosion measures are allowed for use in the areas specified in 5.2.1, even a combination of different anticorrosion protection methods may also be applied to the same structural member. Normally, the following combinations are to be applied according to the performance of corrosion resistant steel:

Anticorrosion measures for cargo oil tank in crude oil tanker Table 5.3.2

Structural member		Upper deck	Inner bottom plating
Corrosion resistant method	Case 1	RCU	RCB
	Case 2	PSPC-COT	RCB
	Case 3	RCU	PSPC-COT
	Case 4	RCW	RCW

Note: Corrosion resistant steel and coating protection may be applied to the same structural member.

5.3.3 Where the corrosion resistant steel is used for protection of cargo oil tank, the corrosion resistance of steel is to be suitable to the areas of application. Corrosion resistant steel with the same brand as that for main structure is to be used in the same area as far as possible.

5.3.4 If steels with different brands are welded together, corrosion test is to be carried out for their welded connections to verify the compatibility of various materials.

5.3.5 Where other anticorrosion measures are necessary in the locations where corrosion resistant steel is applied, such as cathodic protection, the performance of corrosion resistant steel of surrounding structures is not to be damaged.

5.4 Processing of Corrosion Resistant Steel

5.4.1 When the corrosion resistant steel is subject to cold bending, bending radius is preferably not to be less than 3 times thickness of material.

5.4.2 When the corrosion resistant steel is subject to hot work or fire work correction, temperature is preferably not to exceed 900 °C.

5.5 Use of Corrosion Resistant Steel

5.5.1 The corrosion resistant steels used for hull construction are to be approved and applied according to the permitted scope of application stated in certificates.

5.5.2 The corrosion resistant steels are to be welded according to the approved welding procedures.

5.5.3 In the following cases within the range specified in 5.2 of this Chapter, surface treatment and coating protection are to be carried out for structural members based on the various conditions in accordance with the requirements of coating for cargo oil tanks of crude oil tankers in CCS Guidelines for Anticorrosion Inspection of Hull Structure:

(1) Where the corrosion resistant steel is welded to conventional steel, the conventional steel and welds at the welded connection are, in principle, to be coated and the coating is to be extended to cover corrosion resistant steel with a width not less than 100 mm (see Figure 5.5.3(1)).

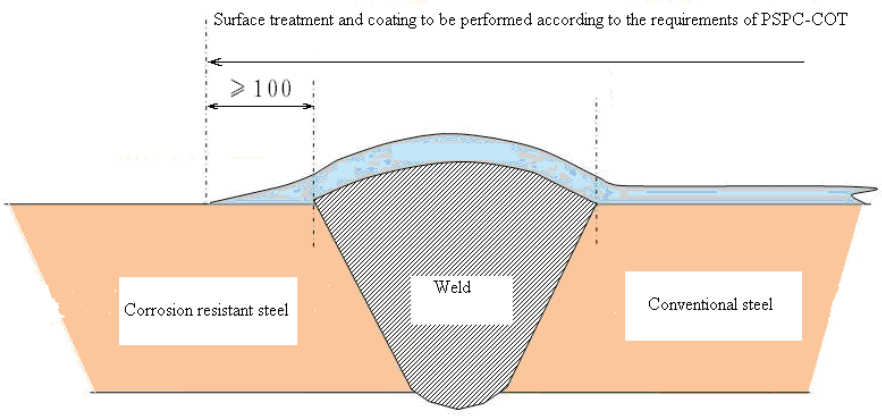

Figure 5.5.3(1) Welding of corrosion resistant steel to conventional steel

(2) When the welding consumables not indicated in approval certificates are used, or two corrosion resistant steels with different brands are welded together, if the corrosion test for compatibility of different materials as specified in 5.3.4 has not been performed, coating is to be carried out in weld areas, including the adjacent base metals with the minimum width of 100 mm, see Figure 5.5.3(2).

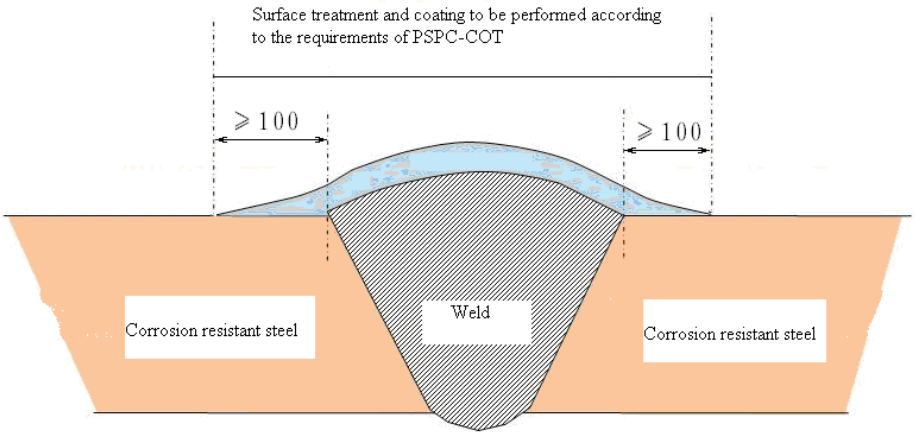

Figure 5.5.3(2) Welding between different corrosion resistant steels

5.5.4 Heat input of welding of corrosion resistant steel is to be not greater than allowable maximum welding heat input confirmed by approval test.

5.5.5 During the hull construction, it is to avoid harmful effects on the surface of corrosion resistant steel as far as possible. If necessary, proper measures may be taken to prevent the effects of splashing, arc striking, scoring, etc. on surface

5.5.6 Where a temporary structure of a different material, such as lug, is required to be fitted on corrosion resistant steel structure or welding consumables not indicated on the approval certificate of corrosion resistant steel are used during construction of the ship, it is recommended that coating is to be applied in way of welds connecting structural members. When the temporary structure is removed, a small portion of it may be left in order not to affect the surface condition of corrosion resistant steel, and coating is to be applied in such area in accordance with the requirements of Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers, see Figure 5.5.6.

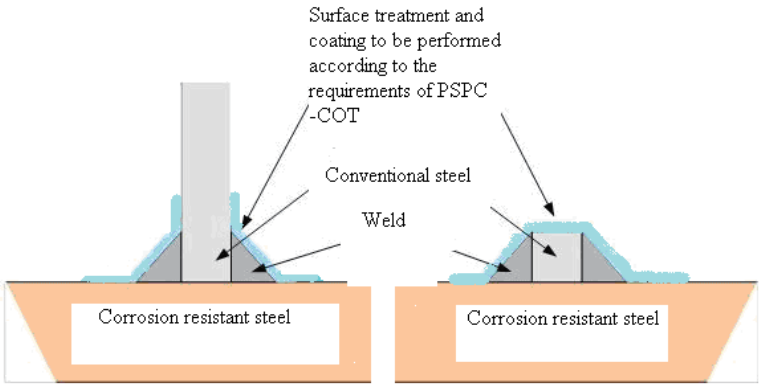

Figure 5.5.6 Protection measures for temporary structure

5.5.7 If the cargo oil tanks of crude oil tankers using the corrosion resistant steel as an alternative means of corrosion protection need to be repaired during service, the following requirements are to be met:

(1) repairs are to be carried out in accordance with the repair method described in the technical file;

(2) If any structural member needs to be replaced, this is to be carried out by the recommended methods described in the technical file;

(3) If the material of corrosion resistant steel structural member needs to be replaced, the steel with the same brand for construction is to be applied; meanwhile, welding consumables with the brand listed in the latest works approval certificate for the steel is to be used.

Where the above-mentioned conditions are not met, the relevant locations are to be coated in accordance with the requirements of Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers.

5.6 Technical File

5.6.1 When the corrosion resistant steel is used as an alternative means of corrosion protection for cargo oil tanks in crude oil tankers, a duplicated copy of relevant technical file is to be prepared and submitted by the shipyard to CCS for confirmation. It is at least to include the following:

(1) copy of works approval certificate;

(2) brand and thickness, position/area of application of corrosion resistant steel (if such information has been marked on the approved drawings, the relevant drawings are also to be placed in the technical file);

(3) local area of application of coating and coating material (if any);

(4) welding method, brand of welding consumables and approved welding procedure;

(5) repair method for pitting corrosion (only for special recommendation by corrosion resistant steel manufacturer);

(6) replacement method of corrosion resistant steel structures; and

(7) report on test of various corrosion resistant steels used and plating thickness measured during the test.

5.6.2 If different corrosion protection methods are used for different locations on board the tanker, the anticorrosion measures in different locations are to be described separately in the technical file.

5.6.3 A duplicated copy of the technical file confirmed by CCS is to be kept on board the tanker throughout its life of service, and relevant documents are to be maintained and renewed for any thickness measurement, repair, replacement, etc. during the tanker's service period.

5.6.4 When the tanker has been repaired, such as replacement of corrosion resistant steel, repair by welding for pitted locations, coating on the corrosion resistant steel structures, etc., the following information related to repair is to be recorded by shipowner or operator, and kept in the technical file for information subject to confirmation by the Surveyor:

(1) repaired locations;

(2) repairing method (repair by welding, replacement of corrosion resistant steel or coating applied);

(3) record of corrosion resistant steel (brand and plating thickness), welding consumables (brand and welding method) and welding procedure (for corrosion resistant steel);

(4) record according to IMO MSC.288(87) Performance Standard for Protective Coatings for Cargo Oil Tanks of Crude Oil Tankers (for coating protection).

Appendix A
Test Procedures for Qualification of Corrosion Resistant Steel for Cargo Tanks in Crude Oil Tankers (Extracted from Appendix to Annex of IMO MSC.289(87))

A1 Scope

The Procedures provides details of the approval test procedure.

A2 Testing

Corrosion resistant steel shall be verified by the following tests.

A2.1 Test on simulated upper deck conditions

A2.1.1 Test condition

Tests on simulated upper deck conditions in cargo oil tank (COT) shall satisfy each of the following conditions:

.1 Corrosion resistant steel and conventional steel shall be tested at the same time.

.2 The chemical composition of conventional steel shall comply with the requirements of table 1. The mechanical properties of the test specimen should be representative of steel used in its intended shipboard application.

Chemical composition for conventional steel (%) Table 1

C	Mn	Si	P	S
0.13 ~ 0.17	1.00 ~ 1.20	0.15 ~ 0.35	0.010 ~ 0.020	0.002 ~ 0.008
Al (acid soluble min)	Nb. max	V max	Ti max	Nb + V + Ti max.
0.015	0.02	0.10	0.02	0.12
Cu max.	Cr max.	Ni max.	Mo max.	Other max.
0.1	0.1	0.1	0.02	0.02 (each)

.3 The tests for corrosion resistant steel shall be carried out for 21, 49, 77 and 98 days. The tests for conventional steel shall be carried out for 98 days. The tests for welded joints shall be carried out for 98 days.

.4 There are to be five test pieces for each test period.

.5 The size of each test piece is 25 ± 1 mm x 60 ± 1 mm × 5 ± 0.5 mm. The surface of the test piece shall be polished with an emery paper #600. The size of the test piece for a welded joint is 25 ± 1 mm × 60 ± 1 mm × 5 ± 0.5 mm, including 15 ± 5 mm width of the weld metal part.

.6 The surface of the test piece, except for the tested surface, shall be protected from corrosive environment in order not to affect the test results.

.7 The test apparatus consists of a double chamber, and the temperature of the outer chamber is to be controlled, as shown in Figure A2.

.8 Simulating the condition of the actual upper deck, the test cycle runs with distilled water and simulated COT gas (4 ± 1% O_2 – 13 ± 2% CO_2 – 100 ± 10 ppm SO_2 – 500 ± 50 ppm H_2S – 83 ± 2% N_2). A sufficient distance between the surface of the test piece and the distilled water is to be kept to avoid splashing of distilled water. The minimum gas flow rate is 100 cc per minute for the first 24 h and 20 cc per minute after 24 h.

.9 The test pieces shall be heated for 19 ± 2 h at 50 ± 2℃ and 3 ± 2 h at 25 ± 2℃ and the transition time is to be at least 1 h. The time for 1 cycle is 24 h. The temperature of the distilled water is to be kept at not higher than 36℃, while the temperature of the test pieces is 50℃.

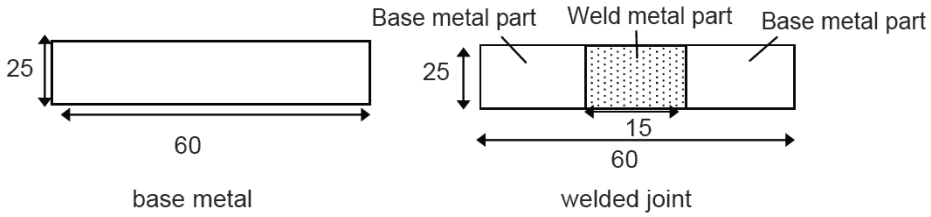

Figure 1 Test piece of this test

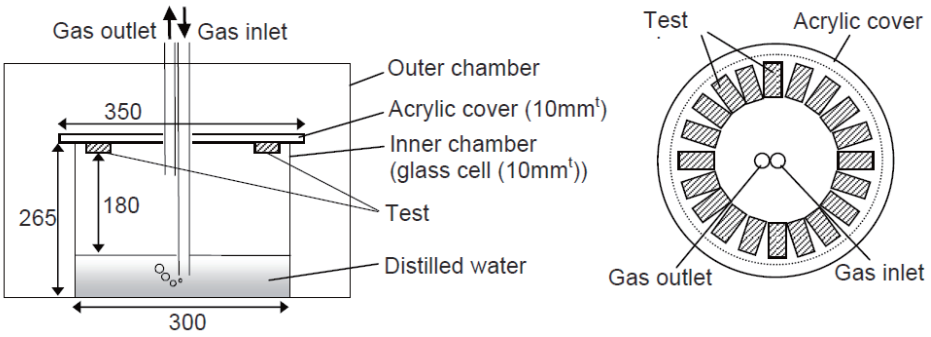

Figure 2 An example of simulated corrosion test apparatus for upper deck

A.2.1.2 Test results of base metal

Prior to testing, the following measured data shall be reported:

.1 size and weight of the test piece;

and after testing, the following measured data shall be reported:

.2 weight loss (difference between initial weight and weight after testing) of conventional steel (Wc) and corrosion resistant steel (W_{21}, W_{49}, W_{77} and W_{98});

.3 corrosion loss of conventional steel (CL_C) and corrosion resistant steel (CL_{21}, CL_{49}, CL_{77} and CL_{98}), calculated by the following formulae:

$$CL_C(mm) = \frac{10 \times W_C}{S \times D}$$

$$CL_{21}(mm) = \frac{10 \times W_{21}}{S \times D}$$

$$CL_{49}(mm) = \frac{10 \times W_{49}}{S \times D}$$

$$CL_{77}(mm) = \frac{10 \times W_{77}}{S \times D}$$

$$CL_{98}(mm) = \frac{10 \times W_{98}}{S \times D}$$

whereby: W_C: weight loss of conventional steel (g) (average of five test pieces)
W_{21}: weight loss of corrosion resistant steel after 21 days (g) (average of five test pieces)
W_{49}: weight loss of corrosion resistant steel after 49 days (g) (average of five test pieces)
W_{77}: weight loss of corrosion resistant steel after 77 days (g) (average of five test pieces)
W_{98}: weight loss of corrosion resistant steel after 98 days (g) (average of five test pieces)
S: surface area (cm^2)
D: density (g/cm^3).

The test is considered to be carried out appropriately if CL_C is between 0.05 and 0.11 (corrosion rate is between 0.2 and 0.4 mm/year). The concentration of H_2S in simulated COT gas may be increased for adjusting CL_C;

.4 coefficients A and B of corrosion resistant steel, calculated from the test results for 21, 49, 77 and 98 days by least square method.

Corrosion loss of corrosion resistant steel is described as follows:

$$CL = A \times t^B$$

A (mm) and B: coefficient
t: test period (days);

.5 estimated corrosion loss after 25 years (ECL) calculated by the following formula:

$$ECL \text{ (mm)} = A \times (25 \times 365)^B$$

A2.1.3 Test results of welded joint

The surface boundary between base metal and weld metal shall be observed by microscope at 1,000① times magnification.

A2.1.4 Acceptance criteria

The test results based on requirements of A2.1.2 and A2.1.3 shall satisfy the following criteria:

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① In the opinion of IACS panel upon discussion, 1,000 times magnification would make it difficult to have a correct judgement of the results, therefore the magnification specified in IACS documents is approximately 100 times or 250 times.

.1 *ECL* (mm) ≤ 2 (for base metal); and

.2 no discontinuous surface (e.g., step) between the base metal and weld metal (for welded joint).

A2.1.5 Test report

The test report shall include the following information:

.1 name of the manufacturer;

.2 date of tests;

.3 chemical composition and corrosion resistant process of steel;

.4 test results according to A2.1.2 and A2.1.3; and

.5 judgement according to 2.1.4.

A2.2 Test on simulated inner bottom conditions

A2.2.1 Test condition

Tests on simulated inner bottom conditions in cargo oil tanks (COT) should satisfy each of the following conditions:

.1 The test shall be carried out for 72 h for base metal, and 168 h for welded joint.

.2 There are to be at least five test pieces of corrosion resistant steel for base metal and welded joint, respectively. For comparison, at least five test pieces of base metal of conventional steel should be tested in the same condition.

.3 The size of each test piece is 25 ± 1 mm × 60 ± 1 mm × 5 ± 0.5 mm for a specimen with base metal only, and is 25 ± 1 mm × 60 ± 1 mm × 5 ± 0.5 mm for a specimen with welded joint including 15 ± 5 mm width of weld metal part as shown in Figure 3. The surface of the test pieces shall be polished with an emery paper #600, except a hole for hanging.

.4 The samples are hung in a solution from a fishing line (0.3 mm to 0.4 mm in diameter, made of nylon) to avoid crevice-like and/or localized corrosion. An example of a corrosion test configuration is shown in Figure 4.

.5 The test solution contains 10 mass% NaCl and its pH is 0.85 adjusted by HCl solution. The test solution should be changed to a new one every 24 h to minimize pH change of the test solution. The volume of the solution is more than 20 cc/cm^2 (surface area of test piece). The temperature of the test solution is to be kept at 30 ± 2℃.

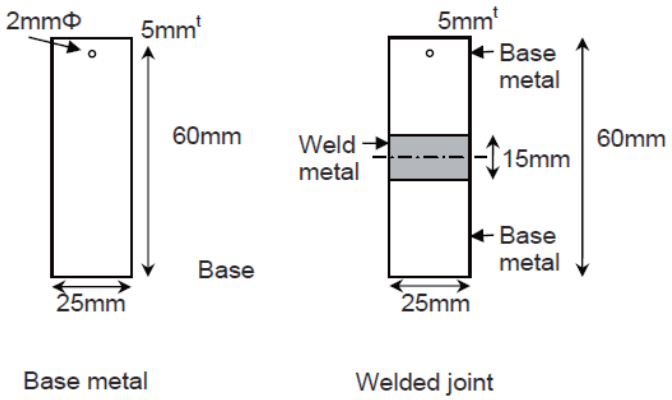

Figure 3 Test piece for this test

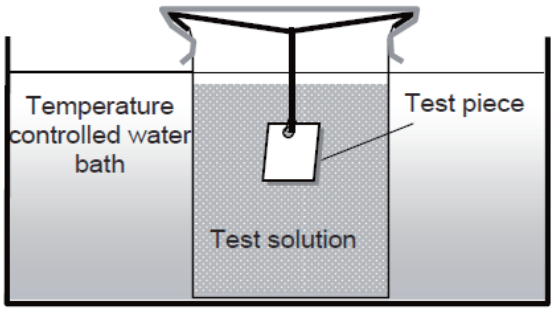

Figure 4 Simulated corrosion test apparatus for inner bottom

A2.2.2 Test results of base metal

Prior to testing, the following data shall be measured and reported:

.1 size and weight of test piece;

and, after testing, the following measured data shall be reported:

.2 weight loss (difference between initial weight and weight after testing);

.3 corrosion rate (*C.R.*) calculated by the following formula:

$$C.R(mm/year) = \frac{365(days) \times 24(hours) \times W \times 10}{S \times 72(hours) \times D}$$

whereby: *W*: weight loss (g); *S*: surface area (cm^2); *D*: density (g/cm^3);

.4 to identify specimen which hold crevice and/or localized corrosion, the *C.R.* is to be plotted on a normal distribution statistic chart. *C.R.* data which deviate from the normal statistical distribution must be eliminated from the test results. An example is shown in Figure 5 for reference;

.5 calculation of average of *C.R.*'s data ($C.R._{ave}$):

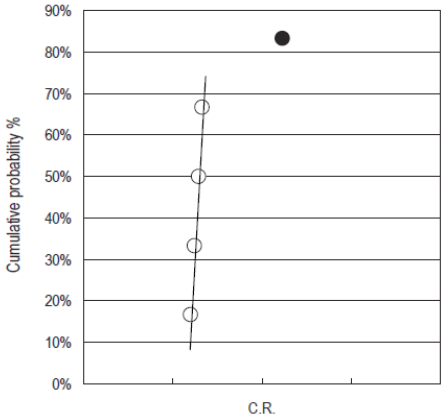

Figure 5 An example of plot of *C.R.s* on a normal distribution chart
(In this case *C.R.* data • should be abandoned and eliminated)

A2.2.3 Test results of welded joint

The surface boundary between base metal and weld metal shall be observed by microscope at 1,000① times magnification.

A2.2.4 Acceptance criteria

The test results based on sections A2.2.2 and A2.2.3 shall satisfy the following criteria:

.1 $C.R._{ave}$ (mm/year) ≤ 1.0 (for base metal); and

.2 no discontinuous surface (e.g. step) between the base metal and weld metal (for welded joint).

A2.2.5 Test report

The test report shall include the following information:

.1 name of the manufacturer;

.2 data of tests;

.3 chemical composition and corrosion resistant process of steel;

.4 test results according to A2.2.2 and A2.2.3; and

.5 judgement according to 2.2.4.

① In the opinion of IACS panel upon discussion, 1,000 times magnification would make it difficult to have a correct judgement of the results, therefore the magnification specified in IACS documents is approximately 100 times or 250 times.

Appendix B
Requirements for Approval of Laboratories Testing Corrosion Resistance of Corrosion Resistant Steel

B1 Scope

The requirements are applicable to approval of laboratories testing corrosion resistance of steel used for upper deck and inner bottom plating of cargo oil tanks of crude oil tankers according to IMO Resolution MSC.289(87) Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers.

B2 Approval basis

1) IMO Resolution MSC.289(87) Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers

2) CCS Procedure for Approval of Service Firm of Inspection & Testing for Products

B3 Basic conditions of laboratory

B3.1 Having clear legal status and capability of undertaking legal liability, and its activities are to comply with the requirements of national laws and regulations.

B3.2 Having Laboratory Approval Certificate issued by China National Accreditation Service for Conformity Assessment (CNAS) and China Metrology Accreditation (CMA).

B3.3 The applicant is to have basic understanding of requirements relating to CCS laboratory approval, and the submitted application information is to be reliable, complete, clear and correct.

B3.4 When carrying out inspection and testing, the laboratory is to obey relevant national provisions, and undertake corresponding legal liability and economic responsibility for accuracy and reliability of the test report. Without the permission of the entrusting party, the laboratory is not to disclose test results and data to any third party.

B4 Quality management system

B4.1 The laboratory is to establish management system complying with approval requirements and operating formally and effectively for more than 6 months, i.e. the management system covers all application scope, satisfies requirements of approval criteria and application specification in special field, and have operational documents. It is to have reasonable organizational structure, definite post responsibility and clear interface between each layer of documents.

B4.2 The management system of laboratory is to cover all locations carrying out inspection/calibration activity or relating to inspection/calibration activity.

B4.3 The organizational structure and personnel responsibilities within each location is to be clear, and when necessary, relevant quality manager and technical manager are to be provided.

B4.4 The laboratories carrying out testing/calibration activity in different locations are to be approved respectively.

B4.5 Having complete test operation procedures.

B4.6 Having complete test records which are kept in a complete manner.

B4.7 The laboratory is to establish management provisions for specimen storage and preservation.

B5 Documents

B5.1 The laboratory is to submit following documents for review by CCS:

1) General conditions: history of carrying out corrosion test of corrosion resistant steel and condition of quality management system;

2) Name/purpose and in-service period of main inspection equipment;

3) Source and composition of comparison steel used for test;

4) Details of gases and chemical medicine mainly used for test;

5) Contents and details of test applying for approval;

6) Flow chart of test items applying for approval and detailed test procedure documents;

7) Detailed test records and report formats of test items applying for approval;

8) Relevant qualification certificates, e.g. ISO17025 and/or ISO9000 certificates, CNAS certificate, CMA metrology accreditation certificate, metrology and calibration certificate for relevant instruments, copies of enterprise legal person certificate, etc.;

9) Laboratory quality system documents (including manual and procedure documents);

10) List of relevant rules, conventions and standards;

11) Personnel qualification certificates.

B6 Personnel qualification

B6.1 Relevant testing personnel in the laboratory are to be subject to training on relevant technical knowledge and operation skills and have corresponding qualification certificates.

B6.2 Testing personnel are to be familiar with relevant test inspection process and requirements for working conditions.

B6.3 Testing personnel are to have inspection and test data analysis capabilities.

B6.4 In addition to capabilities mentioned above, personnel issuing test report are to have the capability of completing inspection report.

B7 Conditions of test equipment

B7.1 The laboratory is at least to have following qualified test equipment and material:

No.	Equipment name	Quantity	Application
1	Electronic analytical balance (precision not lower than 0.1mg)	1	Measuring corrosion weight loss
2	Ultrasonic cleaning instrument	1	Cleaning and removing corrosion products
3	Metallographic polishing machine	1	Specimen polishing
4	Micrometer or vemier caliper (precision not lower than 0.01mm)	1	Specimen dimension measurement
5	Temperature and humidity measuring instruments	2	Measuring temperature and humidity
6*	Quality and flow control meter (precision not lower than 1 ml/min)	2	Gas flow control
7	H_2S detector	2	Detecting H_2S content in the air (at least 1 detector is a fixed type provided with alarm function)
8	SO_2 detector	1	Detecting SO_2 content in the air
9	Metallographic microscope	1	Microstructure observation
10	Testing apparatus for corrosion of upper deck of cargo oil tank	1	Corrosion test
11	Testing apparatus for corrosion of inner bottom plating of cargo oil tank	1	Corrosion test
12	pH meter	1	Measuring pH value of corrosive medium
13	Comparison steel material meeting IMO requirements for standard components	Some	Verifying effectiveness of upper deck test

* Applicable to supply system of semi-mixed gas. Supply system of pure gas branch is to be considered separately.

B7.2 The laboratory is to have necessary specimen processing and handling capability.

B7.3 Test gas ordered by the laboratory is to meet the requirements of accuracy and have quality Certificate.

B7.4 The laboratory is to take necessary measures to guarantee the integrity of test process.

B7.5 The laboratory is to have devices which can automatically record test parameters (temperature).

B8 Documents provided in the laboratory

B8.1 The laboratory is to be provided with following technical documents:

1) Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers (IMO Resolution MSC.289(87));

2) CCS Guidelines for Survey of Corrosion Resistant Steel of Cargo Oil Tanks in Crude Oil Tankers;

3) Standards involving preparation, washing and assessment of corrosion specimens (e.g. international or equivalent national standards such as ISO 8407);

4) Relevant national provisions, self-developed regulations and operational guidelines involving personnel protection against toxic and hazardous gas as well as waste gas and liquid handling.

B9 Approval test program

B9.1 The laboratory applying for approval is to submit approval test program for CCS approval. Approval test program is to define details of test items, relevant methods, conditions and requirements, technical standards, test locations and principles for handling test nonconformities.

B10 Site audit

B10.1 Site audit is at least to include following contents:

(1) checking implementation of documents such as management system document and operational procedure by the laboratory;

(2) checking and confirming training, experience and qualification of personnel of laboratory;

(3) verifying whether the facilities and environment of the laboratory facilitate the correct implementation of inspection, testing and maintenance;

(4) verifying whether suitable methods and procedures are used for carrying out the inspection, testing and maintenance subject to approval in a safe and efficient manner, and whether the sampling, treatment and storage of specimens for inspection and testing are in compliance with the relevant requirements;

(5) verifying whether the laboratory is provided with necessary inspection and testing equipment, whether the gauging instrument and software can meet the required accuracy, whether periodical calibration system has been established, and whether existing gauging equipment are within period of validity;

(6) verifying the accuracy and traceability of inspection and testing results, quality records and reports, and whether the preparation, endorsement, review and issuance of reports are in compliance with relevant requirements;

(7) for the purpose of verifying inspection and testing capability of laboratory, the accuracy, safety and effectiveness of operator during implementation of inspection and testing are to be verified at the same time, and main applied test items are to be witnessed on site;

(8) verifying other necessary audit contents.

B11 Certificates and period of validity

B11.1 If the laboratory is found to satisfy the requirements of the Guidelines by audit, CCS will issue relevant approval certificate of service firm.

B11.2 The approval certificate of service firm is valid for 4 years, and periodical audit is to be carried out according to CCS requirements.

B11.3 Within the period of validity of certificate, in case of any change to the laboratory name, address, main personnel of service firm, main inspection equipment or management system, CCS is to be notified immediately. If it is deemed necessary by CCS, change approval or re-audit is to be carried out.