Materials and Qualification Procedures for Ships

Book C

Procedure 3-3

Approval of works for the manufacture of corrosion resistant steel for cargo oil tanks of crude oil tankers in compliance with IMO Resolution MSC.289(87)

Revision 4, Sept 2015
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1 General Requirements

1.1 The Approval Process

1.1.1 The approval scheme is intended to verify the manufacturer’s capability to provide satisfactory products under effective process, production and inspection controls in accordance with the LR Rules for Materials, Chapter 1.

1.1.2 In order that consideration may be given to Approval of works for the manufacture of corrosion resistant steel for cargo oil tanks of crude oil carrier in compliance with IMO Resolution MSC.289(87), the surveyors are to follow the process defined in Section 2.

1.1.3 Works are to communicate to Surveyors the information which will result in the following reports, each of which is to be submitted to the Materials and NDE Department by the surveyor:

- An initial report giving the information listed in Sections 3 and 4, together with a proposed test programme in accordance with section 5.

- A final report containing the results of approval tests carried out under Sections 5 and 6.

1.1.4 The name of approved works will appear in Lloyd’s Register’s List of Approved Steelmakers and Manufacturers of Rolled Steel Plates, Strip, Sections & Bars which is published on Lloyd’s Register’s CD_live web site (www.cdlive.lr.org).
1.2 Definition and Scope

1.2.1 Corrosion resistant steel for crude oil tankers is steel with improved corrosion resistance than that of conventional steels at the bottom and/or deck head areas of cargo oil tanks of crude oil tankers without the need for coating, and is to be tested and approved to satisfy the requirements specified by IMO MSC.289, in addition to other requirements of mechanical property and weldability.

1.2.2 This procedure only applies to the corrosion resistance aspects of corrosion resistant steel for cargo oil tanks of crude oil tankers. Corrosion resistant steel for cargo oil tanks of crude oil tankers is to additionally be approved in accordance with the relevant procedures for the steel grade (MQPS 3-1, 1-1, etc.).

1.2.3 Only welding procedures and welding consumables tested and approved in compliance with this procedure are applicable to approved corrosion resistant steel. Welding consumables approved for use with the corrosion resistant steel will be listed on the approval certificate.

1.2.4 The procedure for approval of steel with through thickness properties (Z grade) is described in MQPS 3-1.

1.2.5 Where any manufacturing processes are carried out by subcontractors, full details of the sub-contractor must be included and confirmed by survey at the sub-contractor’s facility. Details of this sub-contractor may be specified on the scope of approval.

1.2.6 Where the approval process does not demonstrate capability of certain processes, e.g. heat treatment, such processes may be specifically excluded from the scope of approval.

1.3 Related Documents

1.3.1 Lloyd’s Register’s Rules and Regulations for the Classification of Ships (hereinafter referred to as the LR Rules for Ships).

1.3.2 Lloyd’s Register’s Rules for the Manufacture, Testing and Certification of Materials (hereinafter referred to as the LR Rules for Materials).

1.3.3 Corrosion Protection of Cargo Oil Tanks of Crude Oil Tankers, adopted by Resolution MSC.289 (87) The Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers (hereinafter referred to as IMO MSC.289(87))

1.3.4 IACS UI SC258 (see Appendix of this document). For Application of Regulation 3-11, Part A-1, Chapter II-1 of the SOLAS Convention (Corrosion Protection of Cargo Oil Tanks of Crude Oil Tankers), adopted by Resolution MSC.289 (87) The Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers (hereinafter referred to as IACS SC258)
1.4 Related Materials and Qualification Procedures for Ships

MQPS 3-1. Approval of a Steelworks for the Manufacture of Ship Steels and Boiler and Pressure Vessel Steels with the option of specified Through-Thickness Properties
2 Application for Approval

2.1 Stages of approval

2.1.1 This section sets out the five stages involved in the granting of Lloyd’s Register approval as follows.

(a) Preliminary Review [Stage 1]

The purpose of the preliminary review is to confirm the general capabilities of the works and identify any major non-compliance which will need to be addressed prior to further consideration of the approval process. This review may involve a preliminary assessment visit to the works.

During the course of the review the works shall also demonstrate to the satisfaction of the surveyor that they operate a robust Health & Safety Management System.

Based upon the findings of the preliminary review, the surveyor will issue a report to the company:

- Giving a recommendation that the works approval process proceeds to the next stage (see the Flow Chart below)

  or

- Giving the reasons why the works is not considered suitable for LR approval at this time.

(b) Submission of Works Approval Information [Stage 2]

Following the surveyor’s recommendation to progress with the approval process, the manufacturer will be invited to compile and submit the detailed information requested in Sections 3 and 4 to the local Lloyd’s Register office. The report shall be formatted to follow the sections and sub-sections of this procedure and shall preferably be submitted in electronic format. The report and all supporting documents should be presented in English or annotated in English in an appropriate manner.

Additionally, the manufacturer must submit a proposed test programme in accordance with Section 5.

The local surveyor will review the submitted information from the works and shall conduct an on-site survey during which the contents of the submitted information are verified and any technical or procedural issues related to the approval are resolved.
On satisfactory review of these documents, the surveyor will submit the following to the Materials & NDE Department:

- A short visit report
- The information submitted by the works in accordance with Sections 3 & 4
- A proposed test programme in accordance with Section 5

(c) Review of Submission by Materials & NDE Department [Stage 3]

Lloyd’s Register Materials & NDE Department shall review the submitted information before any manufacture and testing commences. Any testing carried out before notification of test plan acceptance by MNDE shall be at the manufacturer’s risk.

Where necessary, clarification will be sought regarding major issues that are discovered during this stage of review of the submitted information.

The outcome of the Materials & NDE Department review will be conveyed to the surveyor and LR will confirm the approval test programme and any other actions they require the surveyor to carry out during the surveyor’s attendance at the manufacturer whilst witnessing approval manufacture and testing.

The surveyor will communicate this information to the manufacturer.

(d) Approval Tests & Survey [Stage 4]

Following Materials & NDE Department agreement to the test plan, the Works will manufacture the approval rolled products. The Lloyd’s Register surveyor will arrange to attend the works to survey the manufacture and witness the testing of the approval test materials.

In addition, during attendance, the surveyor will follow up on actions suggested by the Materials & NDE Department.

The surveyor will appropriately appraise and endorse all test reports which are required by this procedure.

The surveyor will review a manufacturer’s report which collates all required information in a clear and concise manner. The format of the report must follow the sections and sub-sections of this procedure and it should preferentially be in electronic form. If the report is found to be satisfactory by the surveyor, it will be endorsed by the manufacturer and verified and stamped by the LR surveyor. It will then be forwarded to the Materials & NDE Department for final review and approval.

(e) Review of Results [Stage 5]

The surveyor’s report and endorsed test results will be reviewed by Lloyd’s Register Materials & NDE Department. During this process, points of clarification may be required to be followed up with the surveyor in cooperation with the manufacturer. On satisfactory review the works will be added to Lloyd’s Register’s list of approved
manufacturers and a Certificate of Approval will be issued.

Flow Chart for LR Manufacturer Approval

Stage 1
Section 2.1.1(a)  
Responsibility: Local Surveyor

Stage 2
Section 2.1.1(b)  
Responsibility: Local Surveyor

Stage 3
Section 2.1.1(c)  
Responsibility: MNDR

Stage 4
Section 2.1.1(d)  
Responsibility: Local Surveyor

Stage 5
Section 2.1.1(e)  
Responsibility: MNDR
(f) Unless otherwise agreed with the MNDE Department, the above stages are to be carried out as five distinct entities. In particular, Stage 3 - test plan approval is required before testing is commenced in order to avoid delays in the approval process.

3 Written information required for the manufacturing capability and testing review

3.1 Works Background Information, History, Contact Details and Scope of Approval Request.

3.1.1 The manufacturer is to provide the following product related details in writing to the local surveyor:

(a) Details of the plant and its history in brief.

(b) Grade and corrosion resistant designation of steel for which approval is required e.g. DH32-RCB-Z35. The maximum thickness to be approved for each grade must also be stated.

<table>
<thead>
<tr>
<th>Type of steel</th>
<th>Location where steel is effective</th>
<th>Corrosion Resistant Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolled steel for crude oil cargo tank</td>
<td>For strength deck, ullage space</td>
<td>RCU</td>
</tr>
<tr>
<td></td>
<td>For inner bottom</td>
<td>RCB</td>
</tr>
<tr>
<td></td>
<td>For both strength deck and inner bottom plating</td>
<td>RCW</td>
</tr>
</tbody>
</table>

(c) Delivery condition of the corrosion resistant steel.

Where the steel grade is already approved by the Society a copy of the certificate of approval should be provided which clearly identifies the grades to be approved as corrosion resistant steel.

(d) Brand of welding consumables and welding method for which approval is required.

(e) Estimated total annual production of finished products.

(f) Contact details that are to be listed on the published approved list including sales telephone number, fax number, email address and website.

(g) The year of issue of the copy of the Rules for Materials which are held by the Works and the means whereby possible Rule changes are incorporated into company procedures.

(h) The MQPS documents which are used for the approval application, including their revision numbers.
(i) Details of the inspection and quality control systems established in the works, including details of the personnel involved.

(j) Certification to by external bodies (e.g. ISO 9001, ISO 14001 and/or ISO 18001, etc.), as applicable.

(k) A flow diagram showing all stages of production, testing and inspection points.

(l) An organogram showing the organisational structure shall be submitted indicating the lines of responsibility of the quality manager and production manager and the senior management to whom they report. This should also indicate the quality department with number of personnel qualifications and responsibilities.

3.2 Process Specific Information

3.2.1 The manufacturer is to provide the following process related details in writing to the local surveyor:

(a) Chemical composition range (including additive and/or controlling element percentages to improve corrosion resistance). The chemical composition of the corrosion resistant steel is to be within the range specified for rolled steel in LR Rules for Material. Elements to be added for improving the corrosion resistance and for which content is not specified are to be generally within 1% in total. Criterion for upper and lower limits for all such elements and any relationship between these elements and corrosion resistance are to be clarified.

The effect of variation of each element and those ranges are to be assessed by sufficient corrosion tests to determine the quantitative variations of chemical composition and/or controlling detrimental elements to enhance corrosion resistance.

(b) Test Certificate of proposed conventional steel which will be used for the corrosion test programme.

Differences between the conventional steel grade and the corrosion resistant steel grade are to be summarised. Technical explanation should be given relating to the control of manufacturing process conditions (other than chemical elements used) which are designed to improve corrosion resistance. Criterion for all control parameters and any relationship between these parameters and corrosion resistance should be explained.

(c) If steelmaking is undertaken in the works, the requirements of MQPS 3-0 are also to be provided.

(d) If steelmaking is not undertaken at the works, details of usual suppliers of ingots, continually cast products or other semi-finished products. Details of the products supplied are required. All suppliers must be approved by Lloyd’s Register for the supply of these products.

(e) Where applicable, details of the system employed for checking incoming stock for rolling, acceptance criteria employed and storage prior to use.
(f) Details of each rolling line. This should detail the rolling stands used in each rolling line, methods for controlling temperature, methods of descaling and any equipment used for cooling.

(g) For products produced from continuously cast stock (slabs, blooms billets or bars), proposed minimum amount of hot working expressed as the ratio of the cross-sectional area of the billet (perpendicular to the rolling direction) to the cross-sectional area of the finished rolled product.

(h) For delivery conditions other than quench and tempered, the methods used to determine the re-crystallisation stop temperature, minimum final rolling temperature, Ar3 temperature and normalising temperature should be stated.

(i) For quench and tempered delivery conditions, the controls which are in place for this process, which will include austenitising temperature and holding time and tempering temperature and holding time.

(j) Details of the rolling schedule. This should include, but not be limited to, final rolling temperature and accelerated cooling start and finish temperatures (if applicable)

(k) Details of the reheating and heat treatment facilities after rolling, together with the number of furnaces used, including the dimensions, type of fuel used and facilities for temperature measurement and control. Additionally, positions of thermocouples should be indicated and the method, frequency and acceptance parameters of furnace uniformity surveys. Also included would be details of how each furnace is loaded including restrictions of volume, mass, number of items, etc; details of the loading temperatures, heating rates, holding times (including how these have been determined) and cooling rates. Details of quenching facilities, as applicable.

(l) Facilities and practices for mechanical testing; details should include the normal practices for manufacture and preparation of mechanical test specimens and the name of the manufacturer, model number or description, manufacturer's unique serial number, maximum test capacity and calibration status for tensile and impact test equipment.

(m) Production statistics of mechanical testing (yield strength, tensile strength, elongation and impact properties) for finished products of applicable grades produced including the internal acceptance ranges.

(n) The welding consumable and welding method are to be approved for specific steels in compliance with LR Rules for Materials. A copy of the Certificate of Approval is to be attached

(o) Outline of facilities for corrosion test with post treatment of toxic gases and liquids such as H2S, SOx. Recognised accreditation for chemical testing when applicable (e.g. ISO 17025 M26)
Standard procedure manual for the corrosion test including schematic diagram of corrosion test system
Summary of all required test items, test conditions and criterion for approval as a corrosion resistant structural steel.
(p) Corrosion resistance evaluation results in service when available.

(q) Relevant document for quality control of the corrosion resistant steel.

(r) Repair methods for surface defects and the criteria for evaluation when repairs are required.

(s) Details of any subcontracted activities and particulars relating to the related requirements of the appropriate sections above (e.g., Section (g) applies to subcontracted heat treatment)

4 Survey of the manufacturing, testing and inspection capabilities

4.1 The local surveyor will carry out a survey of the works and subcontractor as applicable, which will include the manufacturing, inspection and testing processes and procedures. As a minimum, the following manufacturing and testing areas are to be included in the survey:

(a) Inspection and checking of incoming rolling stock and storage prior to use.

(b) Process used for reheating ingots, slabs or billets including dimensions, type of fuel used, facilities for temperature measurement and control, and arrangements for sampling and controlling furnace atmosphere.

(c) The rolling process.

(d) Product and test material identification and control

(e) Equipment used to control the rolling process with associated calibration expiry dates.

(f) Facilities for scale removal and for other surface finishing processes

(g) Details of system used for identification of materials at all stages of manufacture and testing.

(h) Visual inspection of all rolled products and associated acceptance standards or criteria.

(i) The frequency of routine ultrasonic examination for quality control purposes

(j) Facilities and control procedures for corrosion testing, metallographic testing and microstructure control

(k) Heat treatment facilities and control
(l) Storage of finished products

(m) Facilities and practices for corrosion testing and relevant mechanical testing

4.2 Where responses to any questions raised by the survey are not forthcoming from the manufacturer, the reasons for omission must be clearly stated in writing.

4.3 Following review of submitted documentation and its verification through the site survey, the surveyor will issue a report of their findings together with a proposed scope of approval testing based upon the guidance given in Section 5 and Section 6. The surveyor will issue a final recommendation stating their opinion as to whether the works should be considered for the next stage of approval.

If the surveyor decides that approval application would not be appropriate at this time, this will be communicated to the works together with the reasons why this decision was made and suggestions as to actions which could be undertaken to improve the application.

If the surveyor deems the approval application to be suitable for progression, the documents listed in 3.2.1, the proposed test programme and the surveyor’s report of activities carried out in Section 4 will be sent to the Materials & NDE Department for specialist review before testing commences.

5 Approval test programmes

5.1 Approval for basic steel grades

5.1.1 Steel grades are to be approved in accordance with MQPS 3-1 Sections 5.2 and Section 5.3.

5.2 Approval for corrosion resistant steel grades

5.2.1 Selection of material

5.2.1.1 The number of casts and test samples planned and selected for approval test are to be sufficient to confirm the aim specification and the control range (upper limit, lower limit) of the chemical elements which are added or intentionally controlled, for improving the corrosion resistance. Where agreed, this may be supported with data submitted by the manufacturer.

The numbers of test samples for each cast are to be in accordance with the requirements of the Appendix of the Annex to IMO MSC.289 (87).

5.2.1.2 Generally, the approval test programme is to be carried out on at least two casts of each product and grade selected for approval testing. This is in respect of specific types of products and if, for example, a works requests approval for both plates and sections, it
will be necessary to carry out tests on two casts rolled into plates and two different casts rolled into sections or bars.

5.2.1.3 The dimensions of the products from each cast submitted for approval tests are to be representative of the range which will be manufactured and should include at least one batch of material of the maximum thickness and width or diameter which it is proposed to supply, i.e. material where the amount of hot working is at the minimum value proposed by the manufacturer.

5.2.1.4 With the exception of hot coiled strip, approval tests are to be carried out on two rolled products of different thickness or diameter from each cast. For plate, wherever possible these tests are to be carried out on one plate 12 mm to 20 mm thick and on another of the maximum thickness that will be produced up to 50 mm. For ingot cast material, one plate is to be representative of the top of the first ingot and the other is to be representative of the last ingot from the ladle. Similarly for continuous casting, one plate is to be representative of the beginning of the cast and the other of material poured when the ladle is nearly empty. Corrosion test specimens with welds are to be prepared from one plate thickness which the steelmaker judges to be suitable for the requirements specified in 5.2.4.7.1(c) and/or 5.2.4.8.1(e).

5.2.1.5 For hot coiled strip, materials for approval are to be taken from two coils selected from different casts. The coils selected are to be representative of material from an ingot top end and an ingot bottom end or, in the case of continuously cast material, from the beginning of one cast and from the end of the other. Additionally one coil should be of the maximum thickness that it is proposed to supply.

5.2.1.6 Testing except for the corrosion test shall be carried out according to Chapter 3 of LR Rules for Materials or to an agreed National Standard or proprietary specification. Details of the applicable testing standards shall be submitted.

5.2.2 General information for corrosion tests (for corrosion environmental condition and specimen)

The acceptance criteria for the corrosion resistance performance of corrosion resistant steel are clearly defined in MSC.289(87), and meeting these criteria requires precise quantitative evaluation of the test performance of the steel under test. The test performed shall comply with the following sections. Any deviations from the test procedure described below shall be approved by Lloyd’s Register prior to the commencement of any test cycle.

5.2.2.1 Surface of specimens, and all the equipment, devices and vessels which shall come in contact with the specimen are to be free from contamination.

5.2.2.2 When the corrosion test is performed at the laboratory of the steel maker with a Lloyd’s Register surveyor in attendance to witness the preparation of the specimens, commencement of the test and post-test evaluation of the specimens, it is not necessary to approve the laboratory.

When the test is performed without a Lloyd’s Register surveyor present, it must be conducted at a laboratory previously approved by Lloyd’s Register to conduct such tests. Approval for such laboratories is conducted in accordance with Materials and Qualification
5.2.2.3 A procedure is to be submitted for the corrosion test, including a schematic diagram of corrosion test system and relevant facilities.

5.2.2.4 Detail of device, equipment and facilities used for corrosion test including maker, model number and specification in detail.

5.2.2.5 Detail of chemicals and/or gases used for corrosion test including maker, grade, guaranteed purity, serial number, certificate and certification body.

5.2.2.6 Electric conductivity of distilled water is to be less than 2μS and the water used is to be kept free from any contamination.

5.2.2.7 Surface of specimens are to be polished with emery paper of 600 grit, cleaned, degreased and an identical surface condition is to be found on all specimens. After preparation, specimens are to be stored in a desiccator if they are not used immediately.

5.2.2.8 The size and weight of specimen is to be measured with accuracy of ±0.01mm, and ±1mg.

5.2.2.9 Factors relevant to the corrosion reaction such as environmental chemical concentration, temperature are to be uniform throughout the reaction vessel.

5.2.3 Pre-Test for Plan Approval

5.2.3.1 Pre-Test for Plan Approval of simulated upper deck conditions

(a) Prior to the approval corrosion test the following simulated upper deck condition pre-test evaluation is to be conducted, either under Lloyd’s Register survey or at an approved test laboratory. Where agreed, this may be supported with data submitted by the manufacturer.

(b) Composition and distribution of gas concentration in the reaction vessel is to be measured and confirmed within the range of 4 ± 1% O₂ - 13 ± 2% CO₂ - 100 ± 10 ppm SO₂ - 500 ± 50 ppm H₂S - 83 ± 2% N₂. Variation of gas concentration with flow rates of gases is also to be recorded and verified.

(c) The heating cycle over each 24h period of the specimen with the distilled water medium is to be confirmed as 19 ± 2 h at 50 ± 2°C and 3 ± 2 h at 25 ± 2°C with the transition time between them being at least 1h, as specified in IACS SC.258 Section 1.1(e) [see Appendix].

(d) The corrosion rate of conventional steel in 98 days corrosion duration is to be evaluated and confirmed within the range between 0.2 and 0.4mm/year, as specified in IMO MSC.289(87).

(e) When corrosion rate of conventional steel is less than the required minimum 0.2mm/year specified in IMO MSC 289(87), the concentration of hydrogen sulfide may be increased to satisfy the requirement. In that case, all the tests for approval are to be carried out with
the increased concentration of hydrogen sulfide.

(f) Any deviations from the test procedure described above shall be approved by Lloyd’s Register prior to the commencement of any test cycle.

5.2.3.2 Pre-Test for Plan Approval of simulated inner bottom conditions

(a) Prior to the approval corrosion test the following simulated inner bottom condition pre-test evaluation is to be conducted, either under Lloyd’s Register survey or at an approved test laboratory. Where agreed, this may be supported with data submitted by the manufacturer.

(b) The corrosion rate of conventional steel is to be evaluated and confirmed to be larger than an agreed rate for three specimens at least.

(c) The temperature of the test solution is to be kept at $30 \pm 2^\circ C$ during corrosion test and is to be recorded continuously.

(d) The pH of test solution is to be measured and confirmed within an agreed range at $30^\circ C$ after 10 times dilution and 100 times dilution with distilled water to avoid acid error of pH glass electrode and hydration effect by NaCl. It is also to be confirmed that the pH meter satisfies repeatability within $\pm 0.05$, linearity $\pm 0.06$ and temperature accuracy within $\pm 0.1^\circ C$ after zero calibrated and span calibrated at pH 1.683, 4.015, 6.853 or 7.400 and 9.139 at $30^\circ C$ following OIML recommendation (R054-e81). All the results are to be recorded and reviewed.

5.2.4 Approval Tests

5.2.4.1 Depending on the areas of cargo oil tanks to which the steel is intended to be applied, a type approval test shall be selected from the appropriate corrosion tests given in Section 5.2.3.1 and 5.2.3.2.

5.2.4.2 Tests should be carried out using both conventional steel and corrosion resistant steel. The conventional steel shall be selected from steels with LR approval for ship construction.

The chemical composition of the conventional steel used in the tests shall comply with Table 1, based on ladle analysis given in the mill certificate. All the elements listed in Table 1 are to be analyzed and reported if not specified in mill sheet. Steel complying with a national standard that meets the requirements of Table 1 is also acceptable.

Table 1 Chemical composition of conventional steel used for the tests

<table>
<thead>
<tr>
<th>Element</th>
<th>Content (wt.%)</th>
<th>Element</th>
<th>Content (wt.%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.13-0.17</td>
<td>Ti</td>
<td>0.02 max.</td>
</tr>
<tr>
<td>Mn</td>
<td>1.00-1.20</td>
<td>Nb+V+Ti</td>
<td>0.12 max.</td>
</tr>
<tr>
<td>Si</td>
<td>0.15-0.35</td>
<td>Cu</td>
<td>0.1 max.</td>
</tr>
<tr>
<td>P</td>
<td>0.010-0.020</td>
<td>Cr</td>
<td>0.1 max.</td>
</tr>
<tr>
<td>S</td>
<td>0.002-0.008</td>
<td>Ni</td>
<td>0.1 max.</td>
</tr>
<tr>
<td>Al (acid soluble)</td>
<td>0.015 min.</td>
<td>Mo</td>
<td>0.02 max.</td>
</tr>
<tr>
<td>Nb</td>
<td>0.02 max.</td>
<td>Others</td>
<td>each 0.02 max.</td>
</tr>
<tr>
<td>V</td>
<td>0.10 max.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.2.4.3 Chemical Analysis is to be carried out with a sample at top of cast to determine C, Mn, Si, P, S, Ni, Cr, Mo, Al, N, Nb, V, Cu, As, Sn, Ti, Sb and intentionally added and/or controlled elements for corrosion resistance.

5.2.4.4 Welding consumables for the welded specimens shall be selected from LR approved welding consumables.

5.2.4.7.1 Approval Test in simulated upper deck conditions

(a) The corrosion resistant steel shall be tested to four different time periods of 21, 49, 77 and 98 days. Time for test specimen replacement and any other corrosion cycle interruption are to be excluded from the corrosion test duration. The conventional steel and weld joints of corrosion resistant steel shall be tested only for 98 days.

(b) Five test specimens shall be tested for each test period. Summary table of specimens used for the corrosion test is to be prepared.

(c) Test surface of specimens are sampled within 2mm from rolled surface. The size of each test piece is 25 ± 1 mm x 60 ± 1 mm x 5 ± 0.5 mm. The size of the test piece for a welded joint is 25 ± 1 mm x 60 ± 1 mm x 5 ± 0.5 mm, including 15 ± 5 mm width of the weld metal part excluding the heat affected zone (HAZ). Surface of specimens are polished with emery paper 600 grit, degreased and identical in surface condition between specimens. See Figure 1.

(d) With the exception of the surface to be tested, the surface of the test piece shall be protected from corrosive environment in order not to affect the test results. Prior to applying protection, the weight of specimens are to be measured.

(e) The test apparatus consists of a double chamber. The temperature of the outer chamber is to be controlled as shown in Figure 2.
(f) All the specimens are to be placed in a corrosion reaction vessel at the start and, subsequently, there may be periodic replacements of specimens. Specimens of conventional steel are to be placed in the corrosion reaction vessel at the same time as those of corrosion resistant steel. Although Figure 2 only shows locations of 20 specimens, the tank can be designed to hold 25 or more specimens; alternatively specimens can be added and removed as necessary so that the appropriate time are achieved within the total timescale of 98 days.

(g) The time and date of replacement of specimens and of stop and restart of corrosion cycle are to be recorded. To remove and replace specimens, the reaction vessel is to be purged with 100% nitrogen gas whilst keeping the specimens in the high temperature region of the cycle until the specimens are dry.

(h) In order to simulating the environmental conditions in the actual upper deck, the test cycle is carried out with distilled water and simulated COT gas (4 ± 1% O₂ - 13 ± 2% CO₂ - 100 ± 10 ppm SO₂ - 500 ± 50 ppm H₂S - 83 ± 2% N₂). Details of component gases are to be recorded and confirmed (manufacturer, composition, purity and test certificate).

(i) The minimum gas flow rate is 100 cc per minute for the first 24 h and 20 cc per minute thereafter. When the dimensions of the tank are modified, the minimum gas flow rate shall be adjusted in proportion to the volume in vapor space. Flow rate of gases into the reaction vessel are to be recorded and confirmed.

(j) All the specimens are placed the same distance from the gas outlet and a sufficient distance is to be kept between the surface of the test piece and the distilled water in order to avoid splashing of distilled water.

(k) Over each 24h period (which is defined as one test cycle) the temperature of the test specimens is to be controlled for 19 ± 2 h at 50 ± 2°C and 3 ± 2 h at 25 ± 2°C, with a transition time of at least 1 h between these temperatures. The temperature of the distilled water is to be kept no higher than 36°C whilst the temperature of the test pieces is 50°C. The temperatures of specimen and distilled water are to be recorded and reviewed continuously.

(m) After completion of all the test procedure and removal of the corrosion product, photographs are to be taken of all tested surfaces with at least 2x magnification which shall be included in the test report.
5.2.4.7.2 Approval Test Results of specimens without weld in simulated upper deck conditions

(a) Weight loss data for each specimen shall be reported together with the average weight losses for Corrosion Resistant Steel specimens and for the conventional steel specimens after the defined test periods.

(b) Corrosion thickness loss can be calculated based on the above data using Equation 1 following equation:

\[ CL(mm) = \frac{10 \times W}{S \times D} \]  

(1)

Where
- CL: Average corrosion loss in thickness (mm)
- W: average weight loss (g)
- S: Surface area (cm\(^2\))
- D: Density (g/cm\(^3\))

(c) To judge the appropriate corrosiveness of the test atmosphere required, the concentration of H\(_2\)S in the simulated COT gas may be adjusted to achieve a corrosion loss in thickness CL of the conventional steel to be within the range of 0.05 to 0.11mm (corrosion rate is between 0.2 and 0.4 mm/year).

(d) Using Equation 2, coefficients A and B of Corrosion Resistant Steel can be calculated from the test results for 21, 49, 77 and 98 days by least square method.

\[ CL = A \times t^B \]  

(2)

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

(e) The estimated corrosion loss in thickness after 25 years ECL can be calculated using Equation 3:

\[ ECL(mm) = A \times (25 \times 365)^B \]  

(3)

(f) After completion of the test procedure and removal of the corrosion product, photographs are to be taken of all tested surfaces with at least 2x magnification and included in the test report.
5.2.4.7.3 Analysis of the Test Results for Corrosion Resistant Steel with weld joint in simulated upper deck conditions

(a) The surface boundary between the base metal and weld metal shall be examined by a microscope with 1,000 times magnification and any discernible surface discontinuity between the base metal and weld metal shall be reported following surface discontinuity evaluation procedure specified in IACS SC.258 Section 3 [see Appendix].

5.2.4.7.4 Acceptance criteria for Test Results in simulated upper deck conditions

(b) The test results on samples selected as described in 5.2.1 shall satisfy the following criteria, as shown in Table 2.

Table 2 Acceptance criteria for approval of Corrosion Resistant Steels in the simulated upper deck condition

<table>
<thead>
<tr>
<th>Specimens</th>
<th>Corrosion loss in thickness (mm)</th>
<th>Microscope examination</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional steel</td>
<td>0.05&lt;CL&lt;0.11</td>
<td>n/a</td>
<td>The test should be adjusted if the CL value is outside of the specified range based on 98 day test results</td>
</tr>
<tr>
<td>Corrosion resistant steels</td>
<td>ECL≤2</td>
<td>n/a</td>
<td>Estimated corrosion loss after 25 years</td>
</tr>
<tr>
<td>Base metal specimens</td>
<td></td>
<td></td>
<td>Under microscope with x1000 magnification following evaluation procedure specified in IACS SC.258 Section 3</td>
</tr>
<tr>
<td>Weld specimens</td>
<td></td>
<td></td>
<td>No surface discontinuity between weld and base metals</td>
</tr>
</tbody>
</table>

5.2.4.8.1 Approval Test in simulated inner bottom conditions

(a) Tests are carried out to simulate inner bottom conditions of cargo oil tanks.

(b) The test shall be carried out for 72 hours for base metal and 168 hours for welded joints. Time for test solution replacement is to be excluded from the corrosion test duration.

(c) At least five test specimens of each type of specimen; namely, corrosion resistant steel base metal, corrosion resistant steel welded joints and conventional base steel, shall be prepared and tested.

(e) One test surface of specimens is to be sampled from within 2mm of the rolled surface. The base metal specimens shall be made to 25 ± 1 mm x 60 ± 1 mm x 5 ± 0.5 and the welded joint specimens to 25 ± 1 mm x 60 ± 1 mm x 5 ± 0.5 mm with a 15 ± 5 mm wide weld metal part excluding HAZ as shown in Figure 3. The surfaces of the test specimens shall be polished with emery paper 600 grit, degreased and identical in surface condition between specimens. Weights of specimens are measured and a table giving details of specimens used for the corrosion testing is to be prepared.
Figure 3 – Test specimens for immersion test

(f) The specimens are suspended in the test solution at the centre of the test vessel using a nylon thread to avoid crevice and/or localized corrosion. The open end of the test vessel is to be covered to prevent evaporation. An example of a corrosion test configuration is shown in Figure 4.

Figure 4 – Corrosion test apparatus simulating tank inner bottom conditions

(g) The test solution shall contain 10% wt. NaCl and its pH is adjusted to 0.85 by HCl solution. The purity of the chemicals employed should be Reagent Grade or higher. The manufacturer, composition, purity, certificate and serial number of the reagents is to be recorded.

Mass and/or weight of reagents and water are to be recorded.

(h) The pH of test solution is to be measured and confirmed within an agreed range after 10 times and 100 times dilution with distilled water to avoid acid error of pH glass electrode. Prior to pH measurement, pH meter with 0.01 in display resolution at least is to be zero calibrated and span calibrated at pH 1.683, 4.015, 6.853 or 7.400 and 9.139 at 30°C following OIML recommendation (R054-e81) with repeatability within ±0.05, linearity ±0.06 and temperature accuracy within ±0.1°C three times with 10 minutes interval. pH standard solutions are to be certificated, and the maker, the guaranteed accuracy and the certificate number are to be recorded. All the results are to be recorded and reviewed.

(i) The volume of the solution shall be determined on the basis that at least 20ml of solution shall be used for each cm² of surface area of test specimens.

(j) The temperature of the test solution is to be kept at 30 ± 2°C during corrosion test and is to be recorded continuously. The test solution should be changed every 24 hours to minimize pH change. Date and time of exchange of solution are to be recorded.
(k) After completion of the test procedure and removal of the corrosion product, photographs are to be taken of all tested surfaces with at least 2x magnification and included in the test report.

(l) It is possible to statistically eliminate one specimen from the reported results if it deviates by more than 25% from the average or normal distribution provided that the cause of the accelerated corrosion is due to localized corrosion around the suspension hole or a surface defect.

5.2.4.8.2 Approval Test Results of specimens without weld in simulated inner bottom conditions

(a) Prior to the testing, the size and weight of test piece shall be measured and reported.

(b) On completion of test, weight loss and corrosion rate shall be calculated and reported for each specimen using Equation 4:

\[
CR = \frac{365 \times 24 \times 10 \times W}{S \times 72 \times D} = \frac{1217.7 \times W}{S \times D} \quad (4)
\]

where:
- CR: Corrosion rate (mm/year),
- W: weight loss (g),
- S: surface area (cm²),
- D: density (g/cm³);

(c) The average CR value of the conventional steel shall be used to judge the validity of the experiment. If the CR value of the conventional steel specimens is significantly deviated from the agreed corrosion rate, the corrosion test shall be repeated.

5.2.4.8.3 Analysis of test results of specimens with weld joint in simulated inner bottom conditions

(a) The surface boundary between the base metal and weld metal shall be examined by a microscope with 1,000 times magnification and any discernible surface discontinuity between the base metal and weld metal shall be reported following surface discontinuity evaluation procedure specified in IACS SC.258 Section 3 [see Appendix].

5.2.4.8.4 Acceptance criteria for approval Test Results in simulated inner bottom conditions

(a) The test results shall satisfy the following criteria:
1. CR value of base metal \( \leq \) 1.0 mm/year; and
2. No discontinuous surface between the base metal and weld metal is present under microscope with x1000 magnification and by the evaluation procedure specified in IACS SC258 Section 3.
6 Specific approval test results

6.1 General

6.1.1 Following Materials & NDE Department agreement to the test plan, the Works will manufacture approval test materials. The various stages of manufacture and all approval testing are to be witnessed by the Lloyd’s Register surveyor.

All test results will be endorsed by the surveyor.

All details listed in Section 6.2 together with the test results will be submitted to the Materials & NDE Department for review.

6.2 Approval test submission

6.2.1 For each cast submitted for approval tests the steelmaker is to provide the following information:

(a) Summary of the manufacturing process

(b) Chemical composition specification to which the steel has been made. This is to include internal controls on chemistry that the works applies to the grade.

(c) Weight of ingots and method of casting.

(d) Results of tests undertaken in accordance with 5.2.2.

(e) Dimensions of slabs or billets or bars.

(f) Mill certificates for conventional steel plates used as comparison samples

6.2.2 The surveyor will submit the information requested in Section 3 and 6.2 to the Materials & NDE Department together with any additional survey reports that were requested by Materials & NDE Department specialists.

Photographs may be used to support the submitted information.
7  Validity of approval certificate

7.1  Initial approval

7.1.1  On satisfactory review of the submitted approval test report Materials & NDE Department will enter the manufacturer onto the List of Approved Manufacturers and an initial approval certificate will be issued.

7.1.2  The approval certificate will state the approved product type (i.e. plate, sections), the grain refine elements, the steel grades and the maximum thickness. Welding consumables approved for use with the corrosion resistant steel will be listed and, if specified through-thickness properties are approved, the appropriate details will be stated.

7.1.3  The initial approval certificate will have a validity of three years.

7.2  Extension of the scope of approval

7.2.1  Manufacturers who intend to extend their scope of approval will be required to repeat the approval process in Section 2 and the scope of information to be submitted and test program is to be agreed with Materials & NDE Department.

7.2.2  Every new consumable that is to be approved for use with an approved corrosion resistant steel will require addition corrosion tests in accordance with this procedure.

7.3  Re-approval of works

7.3.1  For the validity to be renewed for a further three years the Surveyors should undertake a periodic inspection in accordance with Procedure 1-1.

7.3.2  It is a Rule requirement that during material surveys the works will be subject to regular visits to confirm continued compliance with the original approval. The frequency of visits will depend on the frequency of material surveys. Records of these visits will be kept by the surveyors.

7.3.3  Manufacturers that have not produced products under Lloyd’s Register survey during the approval period must either conduct new approval tests (according to Sections 5 and 6) or contact Lloyd’s Register to agree on any additional requirements to continue approval.

7.3.4  Where a manufacturer physically moves the location of an approved works from the approved location to a new site, the manufacturer will be required to follow the initial approval process in full unless they can present a satisfactory case to the MNDE Dept that this would not be necessary.
For Application of Regulation 3-11, Part A-1, Chapter II-1 of the SOLAS Convention (Corrosion Protection of Cargo Oil Tanks of Crude Oil Tankers), adopted by Resolution MSC.289 (87) The Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers

Content

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PSPC-COT Alt 3.4 Area of Application
PSPC-COT Alt 4 Approval
PSPC-COT Alt 5 Inspection and Verification Requirements
PSPC-COT Alt Appendix Test Procedures for Qualification of Corrosion Resistant Steel for Cargo Tanks in Crude Oil Tankers

Notes:

1. This UI is to be applied by IACS Societies for ships subject to SOLAS Chapter II-1, Part A-1, Reg.3-11, as amended by resolution MSC.291 (87) when acting as a recognized organization, authorized by flag State Administrations to act on their behalf, unless otherwise advised, from 1 January 2013.

2. Rev.0 to the interpretation is applicable to members for ships contracted for construction on or after 1 January 2013.

3. The “contracted for construction” date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of “contract for construction”, refer to IACS Procedural Requirement (PR) No. 29.
PSPC-COT Alt 2.1 General Principles

Interpretation

1. Normal and higher strength *Corrosion Resistant Steels* as defined within this UI, is steel whose corrosion resistance performance in the bottom or top of the internal cargo oil tank is tested and approved to satisfy the requirements in this MSC.289 (87) in addition to other relevant requirements for ship material, structure strength and construction. It is not the intention of this document to suggest that Corrosion Resistant Steels be used for corrosion resistant applications in other areas of a vessel.

2. *Corrosion Resistant Steels* are similar to conventional ship construction steels in terms of chemical composition and mechanical properties.

3. The weldability of *Corrosion Resistant Steels* is similar to the weldability of conventional ship construction steels and therefore normal shipyard welding requirements in terms of qualification by the approval of welding consumables and welding procedure qualification also apply.
PSPC-COT Alt 2.2 Technical File

Interpretation

1. The shipbuilder is to prepare and submit the Technical File to the Administration for verification. If the applicable corrosion protection method varies for different locations, the information required for the technical file is to include each location and corrosion protection method separately. Once verified, one copy of the Technical File is to be placed onboard the ship. The following construction records are to be included in the Technical File:

1.1 The copy of the Type Approval Certificate.

1.2 Other technical data is to include:

   (a) Detail of the brand of welding consumables and welding process used.

   (b) Repair method. Only to be included when specially recommended by the manufacturer of corrosion resistant steel.

1.3 Application records

   (a) Areas of application / location of corrosion resistant steel.

   (b) Brand of corrosion resistant steel and thickness.

Note: Items (a) and (b) above may be substituted by the information given in the hull-related approved drawings. However, each brand of corrosion resistant steel used and its location is to be indicated on the approved drawings, the drawings are to be included in the Technical File.

1.4 The test certificates and actual measured values of plate thickness of each corrosion resistant steel, and individual welding conditions need not be included.

2. After the ship enters service, the ship owner or operator is to maintain repair data in the Technical File for review by the Administration. The information required is to include each location and corrosion protection method separately. These records should include:

2.1 Where repairs are made in service to the cargo oil tank in which corrosion resistant steel is used, the following information is to be added to the Technical File.

   (a) Areas of repair work

   (b) Repair method (replacement by corrosion resistant steel or coating)

   (c) Records of the brand of corrosion resistant steel used, plate thickness and welding consumables (brand name and welding method) if corrosion resistant steel is used.

   (d) Records in accordance with Performance Standard for Protective Coatings for Cargo Oil Tanks (MSC.288 (87)), if coating is used.

2.2 Repairs that require records to be maintained as mentioned in paragraph 2.1 above include the following:

   (a) Replacement by corrosion resistant steel
(b) Application of coating on members in which corrosion resistant steel is used (including cases where corrosion resistant steel is replaced with conventional steel and coating). (Note 1)

(c) Repairs of pitted parts. (Note 2)

Note 1: Details of coating on repairs to corrosion resistant steel are to be recorded in the Corrosion Resistant Steel Technical File. In such cases, duplicates of these coating records do not need to be included in the Coating Technical File.

Note 2: The wastage limit of the pitted part or area is to be as deemed appropriate by the Classification Society and/or Administration. However, the standard value of the permissible wastage amount is to be taken as about 40% of the original thickness. In this case weld repairs are required. Only welding consumables approved for the relevant corrosion resistant steel are to be used. The full depth of the pitting is to be filled up by the weld metal. If non-approved welding consumables are used, an appropriate area around the repaired part is to be coated suitably after the repairs in accordance with the IMO Performance Standard for Protective Coatings for Cargo Oil Tanks.

2.3 Plate thickness records during periodical surveys need not be recorded in the Technical File.
PSPC-COT Alt 3.3 Special Application

Interpretation

1. Where other items of structure, such as appurtenances, are not clearly identified, the application of the PSPC-COT Alt to these items is described here.

1.1 Means of access, to be used for ship inspections, which are not integral to the ship structure.

1.1.1 Permanent means of access which are not integral to the ship's structure include:

- Ladders
- Rails
- Independent platforms
- Steps

1.1.2 Appropriate corrosion protection measures are to be adopted for permanent means of access mentioned in paragraph 1.1.1 above.

1.1.3 When corrosion resistant steel is used, in principle, a corrosion resistant steel of the same brand as used in the main structure is to be used for the means of access and the attachments.

1.1.4 When conventional steel is used, and is welded to corrosion resistant steel, corrosion protection measures for the attachment and weld are recommended to be in accordance with Performance Standard for Protective Coatings for Cargo Oil Tanks (MSC.288 (87)).

1.1.5 Other corrosion protection measures are to be left to the discretion of the Administration.

1.1.6 Where other corrosion protection measures other than those stated above, for example cathodic protection are used, the performance of the corrosion resistant steel of the surrounding structure is not to be impaired.

1.2 Access arrangements integral to the ship's structure

1.2.1 The phrase "Access arrangements that are integral to the ship structure" in paragraph 3.2.2 of the Annex to Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks (MSC.291(87)) means access arrangements integral to the ship structure such as the items mentioned below, for access in the cargo oil tanks.

- Stiffeners and girders with increased depth for walkways

1.2.2 Appropriate corrosion protection measures are to be adopted for access arrangement given in paragraph 1.2.1. If coating is applied, the provisions of Performance Standard for Protective Coatings for Cargo Oil Tanks (MSC.288 (87)) are to be followed. If corrosion resistant steel is used on the above arrangements, in principle, corrosion resistant steel of the same brand/type as that used in the cargo oil tanks, is to be used.
1.3 Supporting members, etc.

1.3.1 It is recommended that pipes and supporting members for measuring equipment or outfitting items that are not strength members of the hull be protected either by coating or by use of corrosion resistant steel in accordance with the provisions of paragraph 1.1.4.

1.4 Work Attachments

1.4.1 In the case of attachments (conventional steel) used only during construction work such as hanging pieces, if welding consumables which are not indicated on the Type Approval Certificate of the corrosion resistant steel are used, it is recommended that the welded part is coated in accordance with Fig. 3.3.1.

![Fig. 3.3.1 Range of coating when work attachments are welded to corrosion resistant steel](image-url)
PSPC-COT Alt 3.4 Area of Application

Interpretation

1. Structural members in the COT that require protection measures against corrosion are specified in MSC.289 (87) The Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks of Crude Oil Tankers.

2. Different methods of corrosion protection (coating and corrosion resistant steel) may be adopted for (a) and (b) above. Moreover, a combination of different corrosion protection methods may be used for each of the structural members within the areas identified by (a) and (b).

3. Acceptable combinations of corrosion protection methods are shown in Table 1.

**Table 1 - Acceptable combinations of corrosion protection methods**

<table>
<thead>
<tr>
<th>Member</th>
<th>Lower surface of strength deck (a)</th>
<th>Upper surface of inner bottom plating (b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosion protection method</td>
<td>Case 1 Corrosion resistant steel – Brand A*</td>
<td>Corrosion resistant steel – Brand B*</td>
</tr>
<tr>
<td></td>
<td>Case 2 Coating</td>
<td>Corrosion resistant steel – Brand B*</td>
</tr>
<tr>
<td></td>
<td>Case 3 Corrosion resistant steel – Brand A*</td>
<td>Coating</td>
</tr>
<tr>
<td></td>
<td>Case 4 Corrosion resistant steel – Brand C*</td>
<td>Corrosion resistant steel – Brand C*</td>
</tr>
</tbody>
</table>

*Corrosion Resistant Steel and coating may be used on the same member.

4. If different corrosion protection methods (coating and corrosion resistant steel) are selected for either (a) or (b), the selected procedure for each member is to comply with the relevant performance standards.

5. Where corrosion resistant steel is used it is to be type approved by the Administration.

![Figure 3.4.1](image_url)

6. Where different brands of corrosion resistant steels are used in the same structural member, see Figure 3.4.1, the weld joining the two different steels is to be coated. Coating is to be in accordance with Performance Standard for Protective Coatings for Cargo Oil Tanks (MSC.288 (87)). However, coating of the weld is not required if the welding consumable used to produce the weld has been subject to the necessary corrosion tests. In such a case, a type approval certificate is required for the both steel brands in association with the welding consumable used.
7. When corrosion resistant steel and conventional steel are used together in an area where corrosion protection is necessary, see Figure 3.4.2., the conventional steel and the weld is to be coated in accordance with Performance Standard for Protective Coatings for Cargo Oil Tanks (MSC.288 (87)).

![Figure 3.4.2](image)

8. Where the welding consumable used is different from that indicated on the Type Approval Certificate of corrosion resistant steel, the weld is to be coated in accordance with Performance Standard for Protective Coatings for COT (MSC.288 (87)), see Figure 3.4.3.

![Figure 3.4.3](image)
PSPC-COT Alt 4 Approval

Interpretation

1. Approval procedure

1.1 The steel must be approved and graded accordingly.

1.2 The approval procedure for corrosion testing of corrosion resistant steel is described in the Annex to Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks (MSC.289 (87)).

1.3 The Administration’s approval is not needed for the testing laboratory where a surveyor of the Administration is present at specified stages to witness the approval tests.

1.4 In the case where the Administration is not present at specified stages to witness the approval tests, the testing laboratory is to be approved.

1.5 Where the scope of approval changes, for example for additions to the applicable welding consumables, the effects of these changes are to be subjected to corrosion resistance tests for the welded joints specified in the Annex to Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks (MSC.289(87)).

2. Type Approval Certificate

2.1 The Type Approval Certificate for approved corrosion resistant steel is to include the following items:

   (a) Brand name, manufacturer and certificate number

   (b) Steel grade and area of application designation

   (c) Chemical composition range (including additive and/or controlling element percentages to improve corrosion resistance)

   (d) Maximum thickness

   (e) Steelmaking process

   (f) Casting process

   (g) Delivery condition

   (h) Brand of welding consumables and welding method

   (i) Period of validity of approval

2.2 The Type Approval Certificate is valid for a maximum period of 5 years from the date of approval. When the renewal of approval is carried out, the period of validity will be a maximum period of 5 years from the next day after the expiry date of the previous validity.
PSPC-COT Alt 5 Inspection and Verification Requirements

Interpretation

1. General requirements

1.1 The general requirements are as follows:

(a) Corrosion resistant steel type approved by the Administration is to be used.

(b) Welding consumables used are to be the Brand specified on the type approval certificate.

(c) Welding work is to be implemented according to the approved welding procedure.

(d) The correct use of corrosion resistant steel is verified by engineering review and survey.

(e) The shipbuilder is to prepare a Technical File after the construction work has been completed, and submit it to the Administration for verification.

(f) The Technical File is to be maintained onboard the ship.

1.2 If any of the items in 1.1(a) to 1.1(f) above are not complied with, the Administration notifies the shipbuilder immediately who confirms the corrective action to be followed and its completion. A SOLAS Safety Construction Certificate shall not be issued until all required corrective actions have been closed to the satisfaction of the Administration.

2 Procedure applicable to new ships

2.1. Product inspection is to be carried out as part of material certification. The control range of the chemical composition is determined as follows:

2.1.1 The manufacturer is to supply data relating to the control of applicable chemical elements that the manufacturer has intentionally added or is controlling to improve corrosion resistance. Upper and lower limits for all such elements and any relationship between these elements are to be disclosed. The manufacturer is to obtain the Administration’s approval for these additions and the relationships.

2.1.2 The effect of variation of each element is to be assessed by using sufficient corrosion tests to determine the effects of variation with variations of other elements used to enhance corrosion resistance.

2.1.3 The corrosion resistance test is to be conducted in accordance with Appendix of Annex 3 to Performance Standard for the Alternative Means of Corrosion Protection for Cargo Oil Tanks (MSC.289 (87)).

2.2 Survey during the construction stage

2.2.1 The Administration’s surveyor is to verify that corrosion resistant steel has been used correctly at the appropriate locations.

2.2.2 The verification in 2.2.1 is to be implemented periodically, and the frequency is to be determined on assessment of quality control feedback of each shipyard. However, if some
deficiency is found, the shipyard is to formulate the necessary remedial action with regard to both the deficient location and counter measures to be taken to improve inspection methods.

3. Procedure applicable to ships in service

3.1 If the repair method is described in the Technical File, repairs are to be carried out in accordance with the said method.

3.2 If corrosion resistant steel or coated member is to be replaced, the same corrosion protection method to the one used during construction is recommended.

3.3 If corrosion resistant steel is to be used during repairs, use of the corrosion resistant steel of the same brand as that used during construction is recommended.

3.4 If conventional steel is used in a corrosion resistant steel member that is to be replaced, coating is to be applied to the conventional steel. In this case, it is required that the coating complies with 3.4.3 of the Performance Standard for Protective Coatings for Crude Oil Tanks (MSC.288 (87)), see Figure 3.4.2.

3.5 The application of welding consumables to be used is to be confirmed through the latest Type Approval Certificate of the relevant corrosion resistant steel to ensure conformity (brands of the welding consumables are indicated on the Type Approval Certificate).

3.6 If the welding consumables specified in the Type Approval Certificate for the corrosion resistant steel cannot be used, the weld is to be coated, see Figure 3.4.3. In this case, it is required that the coating complies with 3.4.3 of the Performance Standard for Protective Coatings for Cargo Oil Tanks (MSC.288 (87)).

4. Welding Considerations

4.1 Welding workmanship standards accepted for conventional steel may be used.

4.2 An approved welding procedure is to be used for welding work as appropriate to the grades (excluding subscripts related to corrosion resistance), welding consumables, welding position and plate thickness, etc., of the corrosion resistant steel to be used.
Interpretation

1. Test on simulated upper deck conditions

1.1 Test condition

(a) The chemical composition of the conventional shipbuilding steel used for test purposes (Table 1 in the Annex to the Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks (MSC.289 (87))) is to be based on ladle analysis given in the mill certificate. Steel complying with a national standard that meets the requirements of Table 1 is also acceptable.

(b) All the base material specimens should be located in one tank. Figure 2 in the Annex to the Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks (MSC.289 (87)) only shows locations of 20 specimens. The tank can be designed to hold 25 or more specimens; alternatively specimens can be added and removed as necessary so that the appropriate time periods are achieved within the total timescale of 98 days.

(c) Since certain factors such as control and measurement of temperature and size of chamber may affect the corrosion rate achieved, it should be confirmed that the corrosion rate of conventional steel in the conditions and equipment of the test, satisfies the rate criteria, before carrying out corrosion test for evaluation of corrosion resistant steel.

(d) To remove specimens, the chamber is to be purged with 100% nitrogen gas while the specimens are in the high temperature region until the specimens are dry.

(e) The cycling pattern of specimen temperature and temperature of distilled water should be controlled such that each cycle is as identical as possible throughout the whole corrosion test period. These temperatures must be recorded. See Figure App 1

![Figure App 1 - Schematic view of temperature controlling accuracy of specimens and distilled water during corrosion test](image-url)
(f) The transition time, a, a*, c and c* in figure App 1 is the time from when the cooling and heating commences until the lower or upper temperature is reached, see Figure App 2. The transition of each cycle is to be as identical as possible throughout the whole corrosion test period.

![Figure App 2 - Transition time definition](image)

(g) The temperature of both the specimens and the water is to be continuously recorded throughout the test.

(h) Welded specimens may be tested with the parent material tests or tested separately against 5 conventional steel specimens.

(i) Base material is to be prepared such that the surface to be tested is to be taken from a position within 2 mm of one rolled surface. This surface is to be ground to bare steel and polished to 600 grit finish.

(j) For welded samples, a test assembly is to be made from the same steel cast as the base material test in (i) but may be from a plate of different thickness. The assembly is to be welded using the process and consumable to be approved for use with the base material. The surface to be tested is to be selected such that the width of weld metal, excluding heat affected zone, is to be between 10 and 20 mm. This surface is to be ground to bare steel and polished to 600 grit finish.

(k) Specimens are to be weighed to an accuracy of ± 1 mg.

(l) Where the calculated corrosion loss of conventional steel is less than 0.05 mm/year, the concentration of H₂S may be increased in the simulated cargo oil tank gas. All tests will be carried out at this increased level.

(m) At least 3 values of individual weight loss of conventional steel should be in the range of maximum X and minimum Y measured in grams.

\[
X = \frac{(0.11 \times S \times D)}{10}
\]

\[
Y = \frac{(0.05 \times S \times D)}{10}
\]

Where
- \(S\) = surface area (cm²)
- \(D\) = density (g/cm³)
2. Test on simulated inner bottom conditions

2.1 Test condition

(a) The conventional steel used should also meet the requirements of Table 1 in the Annex to the Performance Standard for Alternative Means of Corrosion Protection for Cargo Oil Tanks (MSC.289 (87)) and interpretations 1.1 (a) above.

(b) Base material is to be prepared such that one surface is to be taken from a position within 2 mm of one rolled surface. All surfaces are to be ground to bare steel and polished to 600 grit finish.

(c) For welded samples, a test assembly is to be made from the same steel cast as the base material test in (e) but may be from a plate of different thickness. The assembly is to be welded using the process and consumable to be approved for use with the base material. The surface to be tested is to be selected such that the width of weld metal, excluding heat affected zone, is to be between 10 and 20 mm. This surface is to be ground to bare steel and polished to 600 grit finish.

(d) Specimens are to be weighed to an accuracy of ± 1 mg.

(e) One specimen that has a corrosion rate deviating from the average corrosion rate by more than +25% may be eliminated from the results, provided that the cause of the accelerated corrosion is demonstrated to be due to localized corrosion around the hanging hole and/or stamp (e.g. crevice corrosion, pitting corrosion, etc.).

3. Interpretation of weld discontinuity

3.1 Preparation of samples after corrosion test

(a) All five samples are to be prepared as follows.

(b) Two full thickness specimens approximately 20 mm long x 5 mm wide are to be sectioned with their principle axis perpendicular to the weld fusion line. Each specimen is to be located such that the weld fusion line is located approximately at its mid length. See Figure App 3.
(c) 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 to reveal the fusion boundary.

(d) A photomicrograph is to be taken at a magnification of approximately 100 X.

3.2 Evaluation of depth step

(a) On the photomicrograph, construct a line A–B, perpendicular to the corrosion surface through the point where fusion line and the surface cross. See Figure App 4.

Figure App 4 - Determination of corrosion depth on photomicrograph

(b) Construct two parallel lines C-D and E-F one representing the higher level, the other the lower level. Each line is to be constructed over a distance of \( \geq 300 \mu m \) from line A-B on the base metal and weld metal side, respectively.

(c) Measure the distance \( r \) mm between the intersection point at line A-B and each average surface line on the photomicrograph.

(d) If the intersection point at line A-B and average surface line of welded metal part is above that of base metal part, then the existence of step should be neglected for this sample.

(e) Calculate the depth of discontinuous step \( R \) in \( \mu m \) from the actual photomicrograph magnification \( M \) as follows.

\[
R(\mu m) = \frac{r(\text{mm}) \times 1000}{M}
\]

3.3 Evaluation of step angle

(a) Evaluation for angle of step is unnecessary if the depth of step calculated on both samples see 3.2, are not greater than 30 \( \mu m \) or if either step exceeds 50 \( \mu m \) for a single specimen. Otherwise the angle of step is to be calculated as follows.

(b) Produce a photomicrograph at a magnification of approximately 250 X, see Figure App 5.
(c) Draw an average surface line C-D for base metal part and E-F for weld metal part.

(d) Find the closest intersection point with the step of the base metal surface profile and the constructed line C-D and the closest intersection point with the step for weld metal constructed line E-F respectively, and connect those two intersection points.

![Figure App 5 - Calculation of step angle](image)

(e) Measure the angle ‘a’ in degrees given by the line C-D and the connected line described in paragraph d, see Figure App 2.

3.4 Acceptance Criteria

(a) If the depth of both steps are less than or equal to 30 µm then the measurement of angle is unnecessary, and the sample is considered to be acceptable.

(b) If the depth of steps on both photomicrographs are less than or equal to 50 µm and in addition if both the measured angles are less than or equal to 15 degrees, then the sample is considered to be acceptable.

(c) If either of the conditions described in paragraphs a or b above are not in compliance, the sample is considered to contain a “discontinuous surface” and fails the test.

(d) Welds should be evaluated as “without discontinuous surface” when all 5 corrosion test samples are considered acceptable.