10 Corrosion Protection

1 Coating of Ballast Water Tanks
The following Rules come into force on 1 May 2010.

Germanischer Lloyd AG

Head Office
Brooktorkai 18, 20457 Hamburg, Germany
Phone: +49 40 36149-0
Fax: +49 40 36149-200
headoffice@gl-group.com

www.gl-group.com

"General Terms and Conditions" of the respective latest edition will be applicable
(see Rules for Classification and Construction, I - Ship Technology, Part 0 - Classification and Surveys).

Reproduction by printing or photostatic means is only permissible with the consent of
Germanischer Lloyd AG.

Published by: Germanischer Lloyd AG, Hamburg
Table of Contents

**Section 1 Certification**

A. Certification of Ballast Water Tank Coatings according to IMO Resolution MSC.215(82) ........................................ 1- 1
B. Certification of Ballast Water Tank Coatings other than IMO Resolution MSC.215(82) ........................................ 1- 5

**Section 2 Coating Application in Ballast Water Tanks**

A. Ballast Water Tanks coated according to IMO Resolution MSC.215(82) ................................................................. 2- 1
B. Ballast Water Tanks not coated according to IMO Resolution MSC.215(82) ................................................................. 2- 3

**Annex A GL Attachment to ISO 15711 - Testing requirements and criteria**

A. General ........................................................................................................................................................................... A- 1
B. Test Plate Preparation ..................................................................................................................................................... A- 1
C. Test Conditions and Criteria ........................................................................................................................................... A- 1
D. Acceptance Criteria (at End of the Period) ................................................................................................................... A- 1

**Annex B Content of the Coating Technical File (CTF)**

A. General ........................................................................................................................................................................... B- 1
B. New Construction Stage ..................................................................................................................................................... B- 1
C. In-Service Maintenance, Repair and Partial Re-Coating ................................................................................................. B- 1
D. Re-Coating ........................................................................................................................................................................ B- 1
E. Health and Safety ............................................................................................................................................................. B- 1

**Annex C Examples for Documentation Records**
Section 1

Certification

A. Certification of Ballast Water Tank Coatings according to IMO Resolution MSC.215(82)

1. General requirements

– Coating systems have to be pre-qualified in a laboratory test prior to be used in ballast water tanks.
– Within the test the whole coating system including the surface preparation will be tested and certified. In case one part of the coating system changes, the test is not valid anymore.

2. Procedures for coating system approvals according to IMO Resolution MSC.215(82)

There are different possibilities to achieve a type approval certificate in accordance with IMO Resolution MSC.215(82):

– Method A – Laboratory test
– or Method B – Five year field exposure
– or Method C – Already existing laboratory test reports described in the following.

All above mentioned methods require further
– Step D – Coating Manufacturer’s inspection described in the following.

For a type approval certification in accordance with IMO Resolution MSC.215(82) either method A + step D or method B + step D or method C + step D have to be fulfilled.

Generally winter and summer type coatings are considered different unless Infrared (IR) Identification and Specific Gravity (SG) demonstrates that they are the same.

2.1 Method A – Laboratory test

– The test is a simulation of a ballast tank in a laboratory wave tank. For an IMO Resolution MSC.215(82) type approval certification it does further include the laboratory testing in a condensation chamber and a heating cabinet.
– For a type approval according to IMO Resolution MSC.215(82) the test panels shall at least fulfil the surface preparation and coating conditions given in Section 2.

– Table 1.1 gives the test results that shall be achieved to fulfil the conditions for a type approval certification in accordance with the IMO Resolution MSC.215(82).

– The laboratory test can also be conducted under different conditions if no IMO Resolution MSC.215(82) type approval certification shall be achieved, e.g. testing of underwater hull coatings for certain conditions. In these cases only parts of the laboratory test described under this Section might be necessary or different time frames/conditions might be applicable. GL Head Office provides further information upon request.

– Equivalent laboratory test methods may be accepted upon review. GL Head Office provides further information upon request.

2.1.1 Wave tank/heating cabinet

The testing facility simulates the conditions in a seawater ballast tank including ship’s movement, adjacent heated tanks and different levels of filling.

– The test is carried out for 180 days and there are 5 panels to be tested.
– The size of each test panel is 200 mm x 400 mm x 3 mm.
– Two of the panels have a U-bar welded on the surface in order to simulate profiles.
– The panels are to be coated with the coating system to be tested, including surface preparation.
– As simulating the condition of actual ballast tank, the test cycle runs for two weeks with natural or artificial seawater and one week empty.
– The temperature of the seawater (artificial or natural) is to be kept at about 35 °C.
– The heating cabinet simulates boundary plating between heated bunker tanks and ballast tanks in the double bottom.
2.1.1.1 Preparation and conditions for the test panels

- Test panel 1: This panel is to be heated for 12 h at 50 °C and cooled for 12 h at 20 °C in order to simulate upper deck condition. The test panel is cyclically splashed with natural or artificial seawater in order to simulate a ship’s pitching and rolling motion. The interval of splashing is 3 s or faster. The panel has a scribe line down to bare steel across width.

- Test panel 2: This panel has a fixed sacrificial zinc anode in order to evaluate the effect of cathodic protection. A circular 8 mm artificial holiday down to bare steel is introduced on the test panel in order to evaluate the effect of the cathodic protection. The test panel is cyclically immersed with natural or artificial seawater.

- Test panel 3: This panel is to be cooled on the reverse side, in order to give a temperature gradient to simulate a cooled bulkhead in a ballast wing tank, and splashed with natural or artificial seawater in order to simulate a ship’s pitching and rolling motion. The gradient of temperature is approximately 20 °C, and the interval of splashing is 3 s or faster. The panel has a scribe line down to bare steel across width.

- Test panel 4: This panel is to be cyclically splashed with natural or artificial seawater in order to simulate a ship’s pitching and rolling motion. The interval of splashing is 3 s or faster. The panel has a scribe line down to bare steel across width.

- Test panel 5: This panel is to be exposed to dry heat for 180 days at 70 °C to simulate boundary plating between heated bunker tanks and ballast tanks in the double bottom.

2.1.1.2 Necessary test results for an IMO Resolution MSC.215(82) certification

The test results shall satisfy the following criteria for epoxy based systems and alternative systems.

Alternative systems are all non epoxy based systems.
Table 1.1  Acceptance criteria wave tank

<table>
<thead>
<tr>
<th>Item</th>
<th>Epoxy-based systems</th>
<th>Alternative systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blisters on panel</td>
<td>No blisters</td>
<td>No blisters</td>
</tr>
<tr>
<td>Rust on panel</td>
<td>Ri 0 (0 %)</td>
<td>Ri 0 (0 %)</td>
</tr>
<tr>
<td>Number of pinholes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adhesive failure</td>
<td>&gt; 3.5 MPa</td>
<td>&gt; 5 MPa</td>
</tr>
<tr>
<td></td>
<td>Adhesive failure</td>
<td>Adhesive failure</td>
</tr>
<tr>
<td></td>
<td>between substrate</td>
<td>between substrate</td>
</tr>
<tr>
<td></td>
<td>and coating or</td>
<td>and coating or</td>
</tr>
<tr>
<td></td>
<td>between coats for</td>
<td>between coats for</td>
</tr>
<tr>
<td></td>
<td>60 % or more of the area.</td>
<td>60 % or more of the area.</td>
</tr>
<tr>
<td>Cohesive failure</td>
<td>&gt; 3 MPa</td>
<td>&gt; 5 MPa</td>
</tr>
<tr>
<td></td>
<td>Cohesive failure</td>
<td>Cohesive failure</td>
</tr>
<tr>
<td></td>
<td>in coating for 40 %</td>
<td>in coating for 40 %</td>
</tr>
<tr>
<td></td>
<td>or more of the area.</td>
<td>or more of the area.</td>
</tr>
<tr>
<td>Cathodic protection current demand calculated from weight loss</td>
<td>&lt; 5 mA/m²</td>
<td>&lt; 5 mA/m²</td>
</tr>
<tr>
<td>Cathodic protection; disbondment from artificial holiday</td>
<td>&lt; 8 mm</td>
<td>&lt; 5 mm</td>
</tr>
<tr>
<td>Undercutting from scribe</td>
<td>&lt; 8 mm</td>
<td>&lt; 5 mm</td>
</tr>
<tr>
<td>U-bar</td>
<td>Any defects, cracking or detachment at the angle or weld will lead to system being failed.</td>
<td>Any defects, cracking or detachment at the angle or weld will lead to system being failed.</td>
</tr>
</tbody>
</table>

2.1.2  Condensation chamber

- The test is carried out for 180 days and there are 2 panels to be tested.
- The size of each test panel is 150 mm x 150 mm x 3 mm.
- The panels are to be coated with the coating system to be tested, including surface preparation.

![Condensation chamber](image)

2.2  Method B – Five year field exposure

Coating systems already in use under real conditions may be accepted for a type approval certification according to IMO Resolution MSC.215(82).

The following conditions shall be fulfilled:

2.2.1  Condition A – Coating system

- The coating system to be type approved shall have a documented field exposure for at least 5 years.
- A survey of all ballast tanks of a selected vessel is to be carried out.
- The reporting of the coating condition shall be in accordance with IACS Recommendation 87.
- The selected vessel shall have ballast tanks in regular use, of which:
  - At least one tank is approximately 2000 m³ or more in capacity,
  - At least one tank is adjacent to a heated tank,
  - At least one tank contains an underdeck exposed to the sun.
- In case the selected vessel does not meet the mentioned requirements the limitations will be clearly stated on the type approval certificate.
- All ballast water tanks shall have a coating condition of not less than ‘GOOD’ according to IACS Recommendation 87, excluding mechanical damages. The results shall be reported. The evaluation is to be done by a GL Representative.
- If the actual applied NDFT in the inspected ballast water tanks is greater than required by the IMO Resolution MSC.215(82), the applied NDFT will be the minimum on the type approval certificate.
### Table 1.2 Acceptance criteria condensation chamber

<table>
<thead>
<tr>
<th>Item</th>
<th>Epoxy-based systems</th>
<th>Alternative systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blisters on panel</td>
<td>No blisters</td>
<td>No blisters</td>
</tr>
<tr>
<td>Rust on panel</td>
<td>Ri 0 (0 %)</td>
<td>Ri 0 (0 %)</td>
</tr>
<tr>
<td>Number of pinholes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Adhesive failure</td>
<td>&gt; 3.5 MPa</td>
<td>&gt; 5 MPa</td>
</tr>
<tr>
<td></td>
<td>Adhesive failure between substrate and coating or between coats for 60 % or more of the area.</td>
<td>Adhesive failure between substrate and coating or between coats for 60 % or more of the area.</td>
</tr>
<tr>
<td>Cohesive failure</td>
<td>&gt; 3 MPa</td>
<td>&gt; 5 MPa</td>
</tr>
<tr>
<td></td>
<td>Cohesive failure in coating for 40 % or more of the area.</td>
<td>Cohesive failure in coating for 40 % or more of the area.</td>
</tr>
</tbody>
</table>

### 2.2.2 Condition B – Coating manufacturer

The coating manufacturer shall submit the following documentation to confirm that the relevant coating system has at least a 5 year field exposure and that there have been no changes in the composition and production conditions in comparison to the current product.

- Original coating application records,
- Original coating specification,
- Original technical data sheets,
- Current coating formulation’s unique identification (Code or number),
- If the mixing ratio of base and curing agent has changed, a statement from the coating manufacturer confirming that the composition mixed product is the same as the original composition. This shall be accompanied by an explanation of the modifications made,
- Current technical data sheet for the current production site,
- Specific Gravity and Infrared Scan identification of original product,
- Specific Gravity and Infrared Scan identification of the current product,
- If original Specific Gravity and Infrared Scan cannot be provided then a statement from the coating manufacturer confirming the readings for the current product are the same as those of the original.

### 2.3 Already existing laboratory test reports

Already existing laboratory test reports may be accepted upon review. Information regarding further details and conditions will be provided by GL Head Office upon request.

### 3. Step D – Coating manufacturer’s inspection

- A work inspection audit will be performed at the manufacturer’s production facilities by a GL Representative.
- Inspection and audit of the manufacturer’s facilities will be based on the requirements of IMO Resolution MSC.215(82).
- Prior to the audit the coating manufacturer shall provide the following information:
  - A detailed list of the production facilities,
  - Names and location of raw material suppliers,
  - Details of quality control procedures employed,
  - List of quality manuals, test procedures and instructions, recording systems, etc.,
  - Details of any sub-contracting agreements, if relevant for the coating system to be type approved,
  - Copy of any relevant certificates with their issue number and/or date, e.g. Quality Management System certification.
- The manufacturer’s quality control system will ensure that all current production is the same formulation as that supplied for the Type Approval Certificate to be issued.
- Batch records including all quality control test results such as viscosity, specific gravity and airless spray characteristics shall be accurately recorded.
- Whenever possible, raw material supply and lot details for each coating batch will be traceable.
- Exceptions may be where bulk supply such as solvents and pre-dissolved solid epoxies are stored in tanks, in which case it may only be possible to record the supplier’s blend.
Dates, batch numbers and quantities supplied to each coating contract will be clearly recorded.

All raw material supply must be accompanied by the supplier’s ‘Certificate of Conformance’. The certificate will include all requirements listed in the coating manufacturer’s quality control system.

Drums must be clearly marked with the details as described on the Type Approval Certificate to be issued.

Product Technical Data Sheets must comply with all IMO Resolution MSC.215(82) requirements. The quality control system will ensure that all Product Technical Data Sheets are current.

In the case that a coating manufacturer wishes to have products which are manufactured in different locations under the same name, then infrared identification and specific gravity shall be used to demonstrate that they are the same coating, or individual type approval tests will be required for the paint manufactured in each location.

The Type Approval Certificate is invalid if the formulation of either the epoxy based system or the shop primer is changed. It is the responsibility of the coating manufacturer to inform class immediately of any changes to the formulation. Failure to inform class of an alteration to the formulation will lead to cancellation of the certificates for that manufacturer’s products.

B. Certification of Ballast Water Tank Coatings other than IMO Resolution MSC.215(82)

1. General requirements

Applied coatings and coating systems for sea water ballast tanks of new buildings have to pass a prequalification test in a laboratory or in form of a field test and need to be type approved by Germanischer Lloyd.

2. Procedures for coating system approvals

- Pre-qualification tests in a laboratory shall be in accordance with ISO 12944 – 6 with the corrosivity category C5-M (medium) and Im2 (medium).
- Cathodic disbondment according to ISO 15711 including the GL attachment in Annex A.
- Equivalent tests may be acceptable upon review by GL Head Office.
- The test plate preparation shall be according to the coating manufacturer’s technical data sheets for the product or system to be tested.
- Systems tested and type approved in accordance with the procedures described under A. are accepted in any case.
- A type approval shall be obtained by the coating manufacturers from GL Head Office.
- A list with type approved coatings and coating systems is obtainable from GL Head Office.
- A type approval does not constitute confirmation of the suitability and compatibility of the coatings in the corrosion protection system. These points are to be ensured by either the yard or the manufacturer of the coating materials.
Section 2

Coating Application in Ballast Water Tanks

A. Ballast Water Tanks coated according to IMO Resolution MSC.215(82)

1. General requirements

Concerning the coating process of seawater ballast tanks during newbuilding requirements from the International Maritime Organisation (IMO) have to be observed (IMO Performance Standard for Protective Coatings – Resolution MSC.215(82)). With these regulations the coating process needs to be surveyed much more detailed and substantial. Since the IMO coating standard is made mandatory stepwise with different implementation dates the survey of the coating process of seawater ballast tanks on newbuildings needs to be distinguished in vessels where it is applicable and in vessels where it is not applicable.

1.1 Instructions for vessels built according to the IMO Resolution MSC.215(82)

Applicable to seawater ballast tanks on all types of vessels of not less than 500 gross tonnage for which at least one of the following items is applicable:

– for which the building contract is placed on or after 1 July 2008; or
– in the absence of a building contract, the keels of which are laid or which are at a similar stage of construction on or after 1 January 2009; or
– the delivery of which is on or after 1 July 2012; or
– the building contract is placed on or after 8 December 2006 in case of being built according to the Common Structural Rules; or
– IMO Resolution MSC.215(82) is agreed on in the building contract.

2. Primary surface preparation

Primary surface preparation is the treatment of the surface on plates and profiles not being processed to larger units. Usually this surface treatment is performed in automated shop primer plants.

2.1 Blasting

– The process shall be grit blasting with sharp-edged abrasive material.
– The blasting process shall generally not be carried out when:
  – the relative humidity is above 85 %; or
  – the surface temperature of the steel surface is less than 3 °C above the dew point.
– The surface cleanliness shall be Sa 2 ½ according to ISO 8501-1.
– Checking of the surface cleanliness shall be carried out at the end of the surface preparation and before the application of the first coating layer.

2.2 Surface profile

– The surface profiles shall be between $R_{z5} = 30–75 \mu m$ according to ISO 8503-1/2.
– Checking of the roughness profile shall be carried out at the end of the surface preparation and before the application of the first coating layer.

2.3 Water soluble salts

– The value for soluble salt in general shall be less than 50 mg/m² according to ISO 8502-6/9.

2.4 Shop primer

– Zinc containing inhibitor free zinc silicate based.
– If equivalent shop primers shall be used Germanischer Lloyd shall be consulted.
– Shop primers must be certified together with the main coating system, see Section 1, A.

3. Secondary surface preparation (profile, salt, dust, etc.)

Secondary surface preparation is the treatment of surfaces on plates and profiles which have been processed to larger units already. This includes in particular welding seams.

3.1 Steel condition

– Prior to coating application surfaces shall be prepared in accordance with ISO 8501-3 Grade P2 (except for edges).
– Edges shall be treated to a rounded radius of minimum 2 mm, or subjected to three pass grinding or at least equivalent process before painting.
– An example of an equivalent process is a dedicated edge grinding machine which will provide the profile equal to radius 2mm or three pass grinding by a single pass. The process needs to be verified.
Edges mean all sharp edges (non-radiused or with a radius less than 2 mm). This includes thermally and mechanically caused edges.

3.2 Surface treatment

– Sa 2 ½ according to ISO 8501-1 on damaged shop primer and on welding seams.

– On remaining areas Sa 2 according to ISO 8501-1 if a shop primer is used which is not certified together with the coating system to be used in accordance with Section 1, A.

– In case a shop primer is part of a certified coating system to be used intact areas may be retained and shall be cleaned by sweep blasting, high-pressure water washing or an equivalent method.

– If a zinc silicate shop primer has passed the pre-qualification as part of an epoxy coating system, it may be used in combination with other certified epoxy coatings, provided that the compatibility has been confirmed by the test described in Section 1, A. without wave movement.

3.3 Surface treatment after erection

This point is only applicable to the surface treatment of areas which need to be treated after final erection and closing of the relevant tank.

– Erection joints shall be treated to St 3 or Sa 2 ½ if possible according to ISO 8501-1. To be decided by the qualified coating inspector.

– Small damages up to 2 % of total area shall be treated to St 3 according to ISO 8501-1.

– Contiguous damages over 25 m² or over 2 % of the total area of the tank shall be treated to Sa 2 ½ according to ISO 8501-1.

– Damage is anything that in the opinion of the qualified coating inspector will prevent the coating from functioning.

– Damage is considered to be in percentage of total area of tank.

– Coatings in overlap shall be feathered. The coating system on e.g. erection joints shall be completely built up according to the coating specification.

3.4 Profile requirements

– In case of full or partial blasting the surface profiles shall be between $R_{y5} = 30 – 75 \mu m$ according to ISO 8503-1/2.

– Checking of the roughness profile shall be carried out at the end of the surface preparation and before the application of the first coating layer.

– Otherwise as recommended by the coating manufacturer.

3.5 Dust

– Dust quantity is rating “1” for dust size class “3”, “4” or “5” in accordance with ISO 8502-3.

– Lower dust size classes to be removed if visible on the surface to be coated without magnification.

3.6 Water soluble salts

– The value for soluble salt in general shall be less than 50 mg/m² according to ISO 8502-6/9.

3.7 Other contaminations

– All other contaminations (e.g. oil, grease) have to be removed.

4. Coating system

4.1 Selection of the coating system

– Coating manufacturers shall have products with documented satisfactory performance records and technical data sheets.

– Coatings need to be certified in accordance with Section 1, A.

– Coating manufactures shall also be capable of rendering adequate technical assistance.

– Coatings for application underneath sun-heated decks or on bulkheads forming boundaries of heated spaces shall be able to withstand repeated heating and/or cooling without becoming brittle.

– Multi-coat systems with each coating layer of contrasting colour is recommended.

– Top coat shall be of a light colour in order to facilitate in-service inspection.

4.2 Coating application

– Each main coating layer shall be appropriately cured before application of the next coat, in accordance with coating manufacturer’s recommendations.

– Surface contaminants such as rust, grease, dust, salts, oil etc. between coating layers shall be removed prior to application with proper equipment and methods according to the coating manufacturer’s recommendation.

– Abrasive inclusions embedded in coating layers shall be removed.

– Drying times and walk-on times given in the coating manufacturer’s data sheets shall be observed.
The specified coating system shall as a minimum be applied in two stripe coats and two full coats.

Stripe coats shall be applied by brush and roller. Roller to be used for scallops, ratholes, etc. only.

The nominal dry film thickness of the coating system shall be minimum 320 μm measured with the 90/10 rule for epoxy-based coatings; other systems to the coating manufacturer’s data sheets and to the type approval certificate.

Maximum total dry film thickness shall be according to coating manufacturer’s data sheets.

The wet film thickness shall be regularly checked during application. Avoid increasing the thickness in an exaggerated way.

Thinner shall be limited to those types and quantities recommended by the manufacturer.

4.3 Miscellaneous

Adequate ventilation is necessary for the proper drying and curing of coating.

Ventilation should be maintained throughout the application process and for a period after application is completed, as recommended by the coating manufacturer.

Coatings shall be applied under controlled humidity and surface conditions, in accordance with the manufacturer’s recommendation.

Coatings shall not be applied when:

- the relative humidity is above 85%; or
- the surface temperature is less than 3 °C above the dew point.

Destructive testing of coating systems or layers shall be avoided.

Dry film thickness shall be measured after each coat for quality control purpose.

Total dry film thickness shall be confirmed and documented after the completion of the final coat, using appropriate thickness gauges.

Any defective areas, e.g., pin-holes, bubbles, void, etc., shall be marked up and appropriately repaired.

All such repairs shall be re-checked and documented.

5. Documentation

Each single step of the coating process, including surface preparation shall be documented and filed.

The collection of the documentation is commonly called Coating Technical File (CTF).

The CTF will include, amongst others, the reports of the certified coating inspector, technical data sheets of the coating system, type approval certificates, procedures for in-service maintenance and repair of coating systems, etc.

The CTF remains on board of the vessel and shall be maintained throughout the life of the vessel. This means that inspection and maintenance of the coating process shall be continuously recorded including location and work specification.

The content of the Coating Technical File is listed in Annex B.

Examples for documentation records are shown in Annex C.

B. Ballast Water Tanks not coated according to IMO Resolution MSC.215(82)

1. General

All seawater ballast tanks shall be provided with a corrosion protection system.

The following corrosion protection systems are to be used:

- coating systems,
- coating systems in combination with a cathodic protection system.

2. Coating systems

2.1 General

The coatings shall be, in accordance with the manufacturer’s specifications, resistant against seawater, coastal water, harbour water and the substances they may contain.

The characteristics, composition and field of application of a coating system shall be documented, i.e. prescribed by the manufacturer of the coating material.

Details of the coating material, how it is to be processed and its suitability for the coating system shall be contained in the product data sheet.

2.2 Approvals

For new buildings, the applied coatings and coating systems shall be approved by Germanischer Lloyd. Refer to Section 1, B.

2.3 Surface preparation

The surface shall be prepared according to the instructions of the manufacturer of the coating material.
Surface preparation is subject to specifications in the product data sheet and shall correspond to a valid surface quality grade, e.g. SIS 055900, ISO 12944-4 or ISO 8501.

Slag and loose weld spatters have to be removed before the coating is applied. Welded or otherwise attached accessory material (tack plates, lugs etc.) shall be completely integrated into the corrosion protection, or otherwise removed.

2.4 Application

The process of application is to be carried out according to the coating manufacturer's instructions.

During application the ambient conditions and procedural instructions are to be complied with, in accordance with the details specified in the manufacturer's instructions and in the approvals.

Surface areas which are obstructed and are thus inadequately exposed to the spraying, exposed edges and corners, as well as weld seams, shall be stripe coated in advance to achieve a sufficient coating thickness.

2.5 Dry film thickness

The dry film thickness of the coating systems shall be in accordance with the approvals and correspond to a minimum of 250 μm.

The prescribed coating thickness is the minimum coating thickness which shall not be undercut at any spot of the coated surface.

2.6 Documentation

The work processes involved in setting up a coating system as well as the coating materials to be used shall be laid down in a coating plan.

The coating plan for ballast water tanks is to be submitted to GL for approval.

The coating protocol is to be compiled in such a way that all work steps executed, including surface preparation and coating materials used, are documented.

This documentation is to be compiled by the coating manufacturer and/or the contractor executing the work and/or the yard. An inspection plan shall be agreed to between the parties involved. The papers pertaining to the documentation shall be signed by these parties. On completion of the coating system, the signed papers constituting the documentation are to be handed to the Surveyor for acceptance. The documentation is to contain the following data:
- location and date,
- ship and the tanks treated,
- manufacturer's specifications for the coating system (number of coatings, total coating thickness, processing conditions),
- product data sheet for the coating and GL approval number,
- contractors and persons carrying out the work,
- surface preparation (procedure, working materials, ambient conditions),
- condition of surface prior to coating (cleanliness, roughness, existing primer, surface quality grade achieved),
- application (procedure, number of coatings),
- application conditions (time, surface/ambient temperature, humidity, dew point, ventilation),
- the date the tanks were first ballasted is to be recorded,
- report of coating thickness measurement and visual inspections,
- signatures of involved parties (yard, coating manufacturer, work contractor).

Coating protocols already in existence and used by coating manufacturers, work contractors, yards and ship owners will be accepted by GL, provided they contain the above data and are signed by all parties involved. Any missing data is to be furnished.

3. Coatings combined with cathodic protection

3.1 Coating

In the case of coatings used in combination with cathodic protection, the provisions under point 2 shall apply for the coatings.

In addition, the coatings have to be resistant against the cathodic protection, i.e. the coatings shall not exhibit any impairment of their purpose up to a potential of – 1200 mV against the copper/copper-sulphate electrode. Proof of resistance against cathodic corrosion protection can be provided in accordance with recognized standards, e.g. ISO 15711. Refer also to Annex A.

3.2 Cathodic protection

For the cathodic protection of ballast water tanks in combination with coatings, sacrificial anodes made of zinc or aluminium may be used.

Tables 2.1 and 2.2 contain recommended alloy compositions for conventional aluminium and zinc anodes.

Zinc and aluminium anodes of differing chemical composition may also be used, provided proof of the cathodic protection ability is provided.
– Zinc anodes may not be used in the event that operating temperatures in excess of 60 °C can be expected.
– Impressed current systems are not permitted in ballast water tanks.

Table 2.1  Sacrificial anodes of zinc alloys for applications in seawater

<table>
<thead>
<tr>
<th>Element</th>
<th>GL-Zn1</th>
<th>GL-Zn2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al</td>
<td>0,10 – 0,50</td>
<td>≤ 0,10</td>
</tr>
<tr>
<td>Cd</td>
<td>0,025 – 0,07</td>
<td>≤ 0,004</td>
</tr>
<tr>
<td>Cu</td>
<td>≤ 0,005</td>
<td>≤ 0,005</td>
</tr>
<tr>
<td>Fe</td>
<td>≤ 0,005</td>
<td>≤ 0,0014</td>
</tr>
<tr>
<td>Pb</td>
<td>≤ 0,006</td>
<td>≤ 0,006</td>
</tr>
<tr>
<td>Zn</td>
<td>≥ 99,22</td>
<td>≥ 99,88</td>
</tr>
</tbody>
</table>

Potential (T = 20 °C)
- 1,03 V Ag/AgCl/Sea
- 1,03 V Ag/AgCl/Sea

Qg (T = 20 °C) 780 Ah/kg 780 Ah/kg

Efficiency (T = 20 °C) 95%

Table 2.2  Sacrificial anodes of aluminium alloys for applications in seawater

<table>
<thead>
<tr>
<th>Element</th>
<th>GL-Al1</th>
<th>GL-Al2</th>
<th>GL-Al3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si</td>
<td>≤ 0,10</td>
<td>≤ 0,10</td>
<td>Si + Fe</td>
</tr>
<tr>
<td>Fe</td>
<td>≤ 0,10</td>
<td>≤ 0,13</td>
<td>≤ 0,10</td>
</tr>
<tr>
<td>Cu</td>
<td>≤ 0,005</td>
<td>≤ 0,005</td>
<td>≤ 0,02</td>
</tr>
<tr>
<td>Mn</td>
<td>N/A</td>
<td>N/A</td>
<td>0,15 – 0,50</td>
</tr>
<tr>
<td>Zn</td>
<td>2,0 – 6,0</td>
<td>4,0 – 6,0</td>
<td>2,0 – 5,0</td>
</tr>
<tr>
<td>Ti</td>
<td>—</td>
<td>—</td>
<td>0,01 – 0,05</td>
</tr>
<tr>
<td>In</td>
<td>0,01 – 0,03</td>
<td>—</td>
<td>0,01 – 0,05</td>
</tr>
<tr>
<td>Sn</td>
<td>—</td>
<td>0,05 – 0,15</td>
<td>—</td>
</tr>
<tr>
<td>Other El.</td>
<td>≤ 0,10</td>
<td>≤ 0,10</td>
<td>≤ 0,15</td>
</tr>
<tr>
<td>Al</td>
<td>Remainder</td>
<td>Remainder</td>
<td>Remainder</td>
</tr>
</tbody>
</table>

Potential (T = 20 °C)
- 1,05 V Ag/AgCl/Sea
- 1,05 V Ag/AgCl/Sea
- 1,05 V Ag/AgCl/Sea

Qg (T = 20 °C) 2000 Ah/kg 2000 Ah/kg 2700 Ah/kg

Efficiency (T = 20 °C) 95%
Annex A

GL Attachement to ISO 15711 - Testing requirements and criteria

A. General
This annex is an attachment to ISO 15711, Paints and varnishes – Determination of resistance to cathodic disbanding of coatings exposed to marine environments’.
This annex shall only be used in combination with ISO 15711.

B. Test Plate Preparation
In total five (+ two) sample plates of hull structural or unalloyed structural steel with the dimension 150 mm x 150 mm and a minimum thickness of 2 mm have to be prepared.
The sample plates shall be coated on both sides. The total dry film thickness shall be measured and documented (see Fig. A.1).
Five plates need to have brazed wire connections. The wire shall have a diameter of 5 mm and a length of 100 mm. The braze point and the edges of the plates shall be sealed additionally (see Fig. A.1).
Shortly before putting the plates into the test solution defined coating defects shall be placed on the side of the sample plate without braze point (see Fig. A.2). The defined coating defect has to be down to bare steel.
The different sample plates will be tested as follows:
- Plate 1/2/3 with coating defects, with cathodic protection
- Plate 4 with coating defects, without cathodic protection
- Plate 5 without coating defects, with cathodic protection
- Plate 6/7 determination of the original data (recommended)

C. Test Conditions and Criteria
Test solution: artificial seawater acc. to ISO 15711
Test potential: - 930 mV Ag / AgCl / KCl ges.
Test duration / period: Plate 1 90 days
Plate 2 180 days
Plate 3/4/5 270 days

D. Acceptance Criteria (at End of the Period)
Blistering (ISO 4628-2:2003): 0(S0)
Disbondment from artificial holiday: ≤ 10 mm
Impact strength (ISO 6272-1:2002):
- Falling weight 1000g
- Falling height 1 m
- After impact 0(S0)a acc. to ISO 4628-4
- No pinholes shall be detected acc. to ASTM D 5162
Adhesion value (ISO 4624:2002):
- Adhesive failure > 3.5 MPa
  Adhesive failure between substrate and coating or between coats for 60 % or more of the areas.
- Cohesive failure ≥ 3 MPa
  Cohesive failure in coating for 40 % or more of the area.
2) 1 - 5: Measure points on front and backside

Fig. A.1 Measurement points for determination of dry film thickness

Coating defect: outer circle 30 mm diameter, 1 mm wide
inner circle 5 mm diameter full
Area not for evaluation

Fig. A.2 Dimensions of the sample plate and coating defects, location of cross cuttings and area, where blistering is allowed on the front side of the sample plate
Annex B

Content of the Coating Technical File (CTF)

A. General
– Specification of the coating system applied to the dedicated seawater ballast tanks and double-side skin spaces.
– Record of the shipyard’s and shipowner’s coating work.
– Detailed criteria for coating selection.
– Job specifications.
– Inspection, maintenance and repair.

B. New Construction Stage
– Copy of Statement of compliance or Type Approval Certificate.
– Copy of Technical Data Sheet including
  – Product name and identification mark and/or number,
  – Materials, components and composition of the coating system, colours,
  – Minimum and maximum dry film thickness,
  – Application methods, tools, and/or machines,
  – Condition of surface to be coated (detrusting grade, cleanness, profile, etc.),
  – Environmental limitations (temperature and humidity).
– Shipyard work records of Coating application, including
  – Applied actual space and area (in square metres) of each component,
  – Applied coating system,
  – Time of coating, thickness, number of layers etc.,
  – Ambient condition during coating,
  – Method of surface preparation.
– Procedures for inspection and repair of coating system during ship construction.
– Coating log issued by the coating inspector, stating that the coating was applied in accordance with the specifications of the coating supplier representative and specifying deviations from specifications (example of daily log and non-conformity report, Annex C).
– Shipyards verified inspection report, including
  – Completion date of inspection,
  – Result of inspection,
  – Remarks (if given),
  – Inspector signature.
– Procedures for in-service maintenance and repair of coating system.

C. In-Service Maintenance, Repair and Partial Re-Coating
– In-service maintenance, repair and partial re-coating activities shall be recorded in the Coating Technical File in accordance with the relevant section of the guidelines for coating maintenance and repair.

D. Re-Coating
– If a full re-coating is carried out, the items specified above shall be recorded in the CTF.
– The CTF shall be kept on board and maintained throughout the life of the ship.

E. Health and Safety
– The shipyard is responsible for implementation of national regulations to ensure the health and safety of individuals and to minimize the risk of fire and explosion.
## Annex C

### Examples for Documentation Records

**Table C.1  Form PSP**

<table>
<thead>
<tr>
<th>COATING LOG (PRIMARY SURFACE PREPARATION)</th>
<th>Sheet No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name/No. of ship</td>
<td></td>
</tr>
<tr>
<td>Plate Numbers</td>
<td></td>
</tr>
<tr>
<td>Inspection date</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENVIRONMENT</th>
<th>Before</th>
<th>Weather changes</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured time</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Temperature (°C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative humidity (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dew point (°C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Temperature (°C)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SURFACE PREPARATION</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface profiles</td>
<td></td>
</tr>
<tr>
<td>Water soluble salts (mg/m²)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SHOP PRIMER</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Product name</td>
<td></td>
</tr>
<tr>
<td>Identification Mark/Number</td>
<td></td>
</tr>
<tr>
<td>Manufacturer’s Recommended DFT</td>
<td></td>
</tr>
<tr>
<td>Measured DFT</td>
<td></td>
</tr>
<tr>
<td>Curing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COATING INSPECTOR’S</th>
<th>Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Signature:</td>
</tr>
</tbody>
</table>
Table C.2  Form SSP

<table>
<thead>
<tr>
<th>COATING LOG (SECONDARY SURFACE PREPARATION)</th>
<th>Sheet No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name/No. of ship</td>
<td></td>
</tr>
<tr>
<td>Part of structure (Block/Tank, No. etc.)</td>
<td></td>
</tr>
<tr>
<td>Construction stage</td>
<td>Block assembly / erection</td>
</tr>
</tbody>
</table>

**STEEL CONDITION CONFIRM**

<table>
<thead>
<tr>
<th>Type of defect</th>
<th>Repair method</th>
<th>Repair confirm / date</th>
</tr>
</thead>
</table>

**SURFACE TREATMENT**

<table>
<thead>
<tr>
<th>Inspection date</th>
<th>Remarks</th>
<th>Method, grade</th>
</tr>
</thead>
</table>

Table C.3  Form CA

<table>
<thead>
<tr>
<th>COATING LOG (COATING APPLICATION)</th>
<th>Sheet No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>First coat</th>
<th>Second coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Before</td>
<td>After</td>
</tr>
</tbody>
</table>

**INSPECTION DATE**

<table>
<thead>
<tr>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Temp. (°C)</td>
</tr>
<tr>
<td>Relative humidity (%)</td>
</tr>
<tr>
<td>Dew point (°C)</td>
</tr>
<tr>
<td>Surface temp. (°C)</td>
</tr>
<tr>
<td>Water soluble salts (mg/m²)</td>
</tr>
<tr>
<td>Dust</td>
</tr>
<tr>
<td>Oil contamination</td>
</tr>
<tr>
<td>Abrasive inclusion</td>
</tr>
<tr>
<td>Stripe coats</td>
</tr>
<tr>
<td>Manufacturer</td>
</tr>
<tr>
<td>Product name of coating</td>
</tr>
<tr>
<td>Product identification mark/no.</td>
</tr>
<tr>
<td>Remarks</td>
</tr>
</tbody>
</table>

**COATING INSPECTOR’S**

<table>
<thead>
<tr>
<th>Name:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Signature:</th>
</tr>
</thead>
</table>
### Table C.4  Form DFT

<table>
<thead>
<tr>
<th>COATING LOG (DRY FILM THICKNESS MEASUREMENT)</th>
<th>Sheet No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name / No. of ship</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Part of structure (Block/Tank No. etc.)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Construction stage</strong></td>
<td>Block assembly / erection</td>
</tr>
</tbody>
</table>

**DRY FILM THICKNESS MEASUREMENT**

<table>
<thead>
<tr>
<th>Dry film thickness (μm)</th>
<th>Number of points</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>320</td>
<td></td>
<td></td>
</tr>
<tr>
<td>288 – 320</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 – 288</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>100 %</td>
</tr>
</tbody>
</table>

**Maximum thickness (μm)**

**Minimum thickness (μm)**

**Remarks**

**FINAL COATING CONDITION CONFIRM**

<table>
<thead>
<tr>
<th>Type of defect</th>
<th>Repair method</th>
<th>Repair confirm / date</th>
</tr>
</thead>
</table>

**COATING INSPECTOR’S**

<table>
<thead>
<tr>
<th>Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature:</td>
</tr>
</tbody>
</table>

---

### Table C.5  Non-conformity report

<table>
<thead>
<tr>
<th>Non-conformity report</th>
<th>Sheet No.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ship:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Tank/Hold No.:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Database:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Part of structure:</strong></td>
<td></td>
</tr>
</tbody>
</table>

**DESCRIPTION OF THE INSPECTION FINDINGS TO BE CORRECTED**

<table>
<thead>
<tr>
<th>Description of findings:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Reference document (daily log):</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Action taken:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Job No.:</th>
<th>Date:</th>
<th>Signature:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship:</td>
<td>Tank / Hold No.:</td>
<td>Database:</td>
</tr>
<tr>
<td>------</td>
<td>-----------------</td>
<td>-----------</td>
</tr>
</tbody>
</table>

**SURFACE PREPARATION**

Method: 

Abrasive: 

Surface temperature: 

Air temperature: 

Relative humidity (max.): 

Dew point: 

Standard archived: 

Rounding of edges: 

Comment: 

Job No.: Date: Signature: 

**COATING APPLICATION**

<table>
<thead>
<tr>
<th>Coat No.</th>
<th>System</th>
<th>Batch No.</th>
<th>Date</th>
<th>Air-temp.</th>
<th>Surf temp.</th>
<th>RH %</th>
<th>Dew point</th>
<th>DFT Meas. *</th>
<th>Specified</th>
</tr>
</thead>
</table>

* Measured minimum and maximum DFT, DFT readings to be attached to daily log 

Comment: 

Job No.: Date: Signature: