Tanker Structure Co-operative Forum

# A Comparison of TSCF and PSPC Ballast Tank Coating Guidance – Owner's Experiences and Best Practice


**SUMMARY**

This paper details the gap analysis carried out between the Tanker Structure Co-operative Forum (TSCF) and Performance Standard for Protective Coatings (PSPC) ballast tank coating guidelines, highlighting the notable differences found between the two sets of guidance which would impact coating performance and seeks to provide recommendations to improve coating performance based on owners' experiences of best practice.





| Reference | Revision N° | Revision Date |
|---|---|---|
| TSCF IP 005/2014 | 0 | 2014/11/22 |

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Working Group Consisted of TSCF members representing Class, Owners and Oil Majors.

# 1 Introduction

The structural boundaries of ballast tanks form a significant part of a tanker's primary structure. Sea water is highly corrosive to unprotected steel and if corrosion is allowed to take hold within ballast tanks it will have a detrimental effect on the integrity of the hull structure and will either reduce the life of the vessel or lead to expensive steel renewals.

In 1992, TSCF published "Condition Evaluation and Maintenance of Tanker Structures" which highlighted the need to maintain the corrosion protection system within ballast tanks.

In 2002, TSCF published "Guidelines for Ballast Tank Coating Systems and Surface Preparation" in response to the unsatisfactory performance of many ballast tank corrosion control coating applications. These guidelines sought to improve coating integrity and longevity by providing best practice guidance on proper paint testing and selection, effective surface preparation, proper coating application and curing, and effective quality assurance procedures.

The TSCF guidelines provide differing levels of standards for minimum target coating life of 10, 15 and 25 years (denoted as TSCF10, TSCF15 and TSCF25).

In order to address the same issue for all vessels, in 2006 IMO adopted Resolution MSC 215(82) "Performance Standard for Protective Coatings for Dedicated Seawater Ballast Tanks in all Types of Ships and Double-Side Skin Spaces of Bulk Carriers" (commonly referred to as PSPC). This resolution came into force in 2008.

PSPC is intended for a minimum target coating life of 15 years (which should make it the equivalent of TSCF15).

At the time of publication of this paper, TSCF Members have over 80 ships in service which have ballast tank coatings applied in accordance with PSPC and another 40 on order or under construction.

The TSCF working group on ballast tank coatings carried out a comprehensive gap analysis between the existing TSCF and PSPC guidelines to identify differences and assess their impact. Members were asked for feedback based on their experiences with coatings applied in accordance with TSCF and PSPC during both construction and in service.

This paper is intended to highlight the notable differences between TSCF and PSPC guidelines which have a significant impact coating performance and provide recommendations to improve coating performance.

# 2 Gap Analysis

A comprehensive gap analysis was carried out of each section of the TSCF and PSPC guidelines, as well as comparisons with other relevant recognized standards such as IACS UI SC 223 and ISO 16145-1.

For each aspect, a comparison was carried out to check the guidance provided by each document and whether there was a significant difference in the guidance provided.

Where it was considered that there was no significant gap between documents, this aspect was disregarded from further discussion.

Where a gap was noted between documents, the working group discussed whether the gap would lead to a difference in coating performance and the key issues were recorded. These gaps were tabulated by a traffic light system to highlight their significance:

RED – gap would lead to a major difference in coating performance
YELLOW – gap would lead to a significant difference in coating performance
GREEN – gap would lead to a minor difference in coating performance
WHITE – equivalence of standards

The full gap analysis including WHITE is detailed in Appendix 1.

The areas where gaps would lead to a difference in coating performance are summarized as follows:

| | | |
|---|---|---|
| Surface Preparation | Block Joints | |
| | Blasting Abrasives | |
| | Secondary Surface Preparation | |
| Coating Application | Stripe Coating | |
| | Bellmouths | |
| | Permanent Means of Access | |
| | Block Holding Primer | |
| Quality Assurance | Environmental Conditions | |
| | Environmental Control and Traceability | |
| | Coating Approval Test Procedures | |
| | Painter Qualifications | |
| | Paint Inspectors | |
| Defect Resolution | Blisters | |

**Table 1 Coating performance gaps identified with traffic light system**

# 3 Key Findings of Gap Analysis

The gaps highlighted in the analysis are categorized and detailed in this section.

## 3.1 Surface Preparation

### 3.1.1 Block Joints

Surface treatment of block joints represented the most major gap between TSCF and PSPC guidelines and created the most significant issue in terms of early coating failure.

The PSPC guidelines for surface treatment of block joints fall significantly below the TSCF15 guidelines:

- PSPC – Power tooling to St3 for block joints
- TSCF10 – Power tooling to St3 for block joints
- TSCF15 – Blasting to Sa2.5, 30-75 microns profile for block joints
- TSCF 25 – Blasting to Sa2.5, 30-75 microns profile for block joints

The PSPC guidelines are intended for a 15 year coating life, but align with the TSCF guidelines for a 10 year coating life. However, ship owners have experienced many failures of coatings on power-tooled block joints even before 10 years service life.

**Figure 1 Example of power-tooled block joint after less than 10 years in service**

Power tooled surfaces have a much smoother profile compared with blasted surfaces which can lead to reduced coating adhesion.

**Recommendation: Block joints should be blasted to Sa2.5, with a profile (Surface roughness) of 30 to 75 microns, using a technique that prevents collateral damage to the surrounding coatings. The following best practice techniques are a selection of those that can be used:**

- **Sponge Jet Blasting**
- **Vacuum Blasting**

### 3.1.2 Blasting Abrasives

Appropriate selection and use of blasting abrasives is important in order to ensure that the required surface profile is achieved and that the surface being prepared is not contaminated in any way.

TSCF provides guidance on abrasive characteristics, pre-qualification testing, in-use testing, and quality assurance aspect. However, a notable omission is a lack of guidance on recycling and re-using abrasives in order to ensure that re-use does not reduce the abrasive's ability to produce the required surface profile, leading to areas of lower quality surface finish.

PSPC provides no guidance on abrasive characteristics at all. This is considered a significant omission considering the importance of achieving the required surface profile and excluding the possibility of surface contamination.

**Recommendation: Abrasives should not be re-used. In future revisions of PSPC adequate certification and testing of abrasive quality should also be included.**

### 3.1.3 Secondary Surface Cleaning

During the gap analysis and review process, the following additional comments were raised which may improve coating quality and productivity.

For surfaces which have been previously blasted and coated and which need re-coating, the use of hydro-blasting to remove the existing coating is a viable alternative to abrasive blasting and would allow yards a greater selection of methods to complete the work, leading to a potential increased productivity. PSPC currently does not cover hydro-blasting as a form of surface preparation.

**Recommendation: Hydroblasting is an acceptable form of surface cleaning, where a suitable surface profile has already been established and strict control over the levels of flash rusting are enforced, and a coating formulated for use over flash rust is used.**

## 3.2 Coating Application

### 3.2.1 Stripe Coating

Stripe coating is required in order to ensure adequate protection of plate and stiffener edges. It should be carefully controlled in order to ensure effective coverage, adequate penetration of the substrate and a dry film thickness (DFT) within tolerance (too thin provides inadequate protection, too thick increases the possibility of paint cracking and exposure of the substrate).

**Figure 2 Example of good stripe coating**

**Figure 3 Inadequate stripe coating leading to breakdown**

TSCF guidance specifies stripe coating to be carried out by brush only. Roller application for stripe coating is considered a lesser standard, with higher DFT and less penetration of substrate. IACS UI SC223 provides additional guidance on this aspect, stating that rollers should only be used for scallops, rat holes, etc.

PSPC does not provide any guidance on how stripe coating should be applied. It is considered that this omission can lead to stripe coating standards suffering in favour of increased productivity rates and should be considered in future revisions of PSPC.

Recent experience has suggested that the coating DFT at newbuild tends to be excessive. This has resulted in the coating cracking, wasting coating and resulting in substandard coating performance. Strict control over the application is required to ensure that the coating is not applied too thickly, and it may result that after the first stripe/full coat the second stripe coat may be omitted.

**Recommendation: Stripe coat is to be carried out with a brush only. Where this is physically impossible a roller may be used, eg Scallops. It is important to ensure that the coating DFT does not become too high, and the requirement for a second stripe coat may be waived if the DFT becomes excessive.**

### 3.2.2 Bellmouths

Coating breakdown is more likely to occur in the area immediately beneath a bellmouth where high flow rates lead to a much higher potential for paint erosion. This erosion is particularly increased when the ballast water contains sediment.

To resolve this issue, TSCF guidance specifies that areas under bellmouths should have extra protection by reinforced coating or coating of increased thickness.

However, PSPC offers no guidance on additional protection under bellmouths and no glass flake paints have been given PSPC approval.

Ship owners have experienced higher rates of coating breakdown under bellmouths on tanks coated to PSPC guidelines. While it is possible to specify locally increased coating thickness to counteract this, it is not possible to specify any reinforced coatings because none have been approved through PSPC.

**Figure 4 Example of corrosion under bellmouth**

**Recommendation: Abrasion resistant coatings if available on PSPC should be specified, such as glass flake. If the abrasion resistant coatings are not available then a higher DFT of at least 500 microns should be specified.**

### 3.2.3 Permanent Means of Access and Non-Integral Outfitting Items

Ballast tanks incorporate permanent means of access and outfitting items such as ladders and rails to ensure adequate access and protection for personnel entering the ballast tank. These items also require protection to ensure their integrity is maintained.

TSCF guidance specifies that coating of all outfit and non-integral items should be the same standard as the tank coatings, including galvanized or corrosion-resistant alloy items.

PSPC recommends coating for non-integral outfitting items, but does not clarify how to deal with specialized surfaces (galvanized, corrosion-resistant alloys, etc.). Instead, this aspect is dealt with in separate MSC Circular 1279 “Guidelines for Corrosion Protection of Permanent Means of Access Arrangements”.

Responsible ship owners place great importance in protecting the safety of personnel at all times and would like to ensure that there is no compromise on coating permanent

means of access, non-integral outfitting items and specialized surfaces. It is considered useful if future revisions of PSPC incorporate the guidance provided in MSC Circular 1279.

**Figure 5 Insufficient coating on outfitting items leading to dangerous situation**

**Recommendation: All permanent means of access and outfitting items within the tank should be coated to the same standard as the tank coatings, including galvanized or corrosion resistant alloy items.**

### 3.2.4 Block Holding Primer

Block holding primer is a temporary quick-drying primer which is applied as temporary protection of blast-cleaned steel. It is sometimes applied to blocks which are intended to be stored prior to assembly. The holding primer must then either be effectively removed before application of the full coating system or it must be ensured that the full coating system can be applied over the top of it without detrimental effect.

TSCF guidelines suggest the use of block holding primers is acceptable for TSCF10 and TSCF15 standards, but not for TSCF25. However, PSPC offers no guidance on the use of block holding primers.

Ship owners experiences of block holding primers concluded that quality of primer application varied between yards, but block holding primers were more likely to fail when blocks were constructed in one yard and transported to another assembly yard by sea, leading to corrosion of the block prior to assembly. Also, failure of the final coating system occurred when the block holding primer was not effectively removed through blasting, thereby creating a weak surface for other coatings.

In order to resolve this issue, two options could be considered:

Future revisions of PSPC should include guidance on the approval, application, removal and compatibility testing of block holding primers.

**Recommendations: Painting to be carried out directly after blasting instead of using block holding primers. Blocks that have been shipped by sea should be fully washed and blast cleaned before full coating application.**

## 3.3 Quality Assurance

### 3.3.1 Environmental Conditions

Coating systems are affected by environmental conditions such as temperature and relative humidity both when being applied and throughout the curing process. Failure to ensure that the correct conditions are maintained throughout can lead to weak or damaged coatings.

TSCF guidance states that dew point differential should be maintained at all times during the painting process, including during curing, as well as a maximum relative humidity of 60%. However, PSPC states that dew point shall be maintained during painting and a maximum relative humidity of 85%, but does not specifically state that it must also be maintained during curing.

Although the increased maximum relative humidity level specified by PSPC can be seen as a reduction in standards, if coating systems are designed for the higher humidity this may not be an issue. However, it is a significant omission not to stipulate that environmental conditions must be maintained throughout curing.

PSPC does not provide clear guidance on painting inside or outside paint cells.

**Recommendation: Painting and curing shall be carried out in a continuously controlled environment, where temperature and humidity variation is to be avoided.**

### 3.3.2 Environmental Control and Traceability

Paints can be damaged by poor environmental controls during transportation and storage periods. Prolonged exposure to excessively cold or hot temperatures can damage the paint chemistry and lead to large-scale coating problems when applied.

TSCF provides some guidance on storage on site and product finger-printing, however it falls short in providing guidance regarding protecting the paint during transportation as well. PSPC provides no guidance at all in this respect. If the paint chemistry is damaged through improper storage or transportation, complying with all aspects of either set of guidelines will be irrelevant.

It is considered that quality control procedures need to be maintained at all times in order to minimise potential damage to the paints. However, for best practice, finger-printing of paints should be applied. This would involve using infrared spectral analysis to check the paint chemistry (density, ash, volume solids and mass content of binder, pigments and non-volatile matter) (e.g. ASTM D7588) in order to compare the paint to be applied with a tested and approved paint sample, thereby ensuring that the quality of the paint to be applied is the same as the approved paint.

**Recommendation: A transportation and storage plan is to be provided by the coating manufacturers that include monitoring of environment during the journey and storage. Fingerprinting of the paints should be carried out.**

### 3.3.3 Coating Approval Test Procedures

Ship owners' experiences of coating applications and in-service issues have highlighted that the test procedures for new PSPC coatings can be improved by including realistic considerations and more representative tests.

If paint is required to be applied on power-tooled surfaces which have a smoother surface profile than blasted surfaces, the paints should be additionally tested on power-tooled surfaces in order to ensure adequate adhesion (though this form of surface

preparation is not recommended) showing that the life expectancy equals the required levels.

Salt levels on paint test panels are very low compared with levels found during construction. It would therefore be more realistic to carry out paint testing on panels with salt levels at upper levels of acceptability according to PSPC.

In addition, PSPC states that coatings to be applied to surfaces in which there will be a temperature differential, the coating shall be able to withstand repeated heating and or cooling without becoming brittle, however no test is currently specified.

The PSPC testing procedures do not carry out any bend testing to assess coating flexibility, nor abrasive tests. On the basis that the hull structure is continually flexing, this is considered a notable omission. This is of particular interest considering that more vessels are traded further into Polar regions and it becomes more important to ensure low temperature in-service performance.

**Figure 6 Paint failure in area of high strain due to insufficient flexibility**

**Figure 7 Paint failure in area of high strain due to insufficient flexibility**

**Recommendation: The laboratory testing procedure for the coatings must match the worst plausible in service application condition allowed by PSPC. This should include compression and tension bend tests, salt contamination, smooth surface profile and temperature cycles, as well as abrasion tests.**

### 3.3.4 Painter Qualifications

Painting is skilled work and requires training to produce consistent high quality coatings. However, it is noted that there are no recognized standards for painter training and qualification in the same way that is carried out for welders.

Training and qualification of painters is a notable omission from both PSPC and TSCF guidelines and ship owners have highlighted that they would be interested in seeing recognized standards for training and qualification and involvement of third party assessors to oversee this.

**Recommendation: Experience of coating team should be confirmed through practical tests, and close monitoring during the initial stages to ensure that the required coating standard is met.**

### 3.3.5 Paint Inspectors

Both TSCF and PSPC provide guidance on provision and qualification of coating inspectors, however ship owners' experiences have highlighted how both sets of guidance could be improved.

TSCF guidance only requires the lead inspector to be certified, however it is considered that more than one qualified inspector per ship is required for most large jobs in order to provide sufficient inspection levels to maintain production levels.

Both sets of guidance allow for equivalent certification standards to NACE or FROSIO. It is considered that accepted equivalencies need to be better defined by administrations in order to maintain standards.

It is standard for both shipyard and owner to both provide their own coating inspectors. While TSCF guidance suggests that the status and authority of each inspector should be stated in the contract, PSPC provides no such guidance and there is a potential for conflict of interest if only the inspector contracted by the shipyard has authority under the guidelines.

Neither set of guidance provides details of minimum numbers of inspectors. Inadequate numbers of inspectors can strain their ability to carry out adequate inspection of large amounts of coating areas and productivity would be improved with greater numbers.

**Recommendation: All coating inspectors should be fully qualified dependant on their expected role. The roles of each person should be outlined within the contract. If the scope of work is large, consideration should be given to having multiple coating inspectors.**

## 3.4 Defect Resolution

### 3.4.1 Blisters

Coating blisters are a localised separation of the paint from the surface and are often filled with fluid. The eventual breakdown of the blister will allow localised corrosion and further paint separation from the surface.

**Figure 8 Example of paint blistering**

The TSCF guidelines consider that blistering is a serious defect which requires investigation and remedial work. However, PSPC offers no clear guidance on unacceptable coating defects and ship owners consider that this is a serious omission.

It is considered that future revisions of PSPC should include some form of guidance on blistering and other defects in order to ensure that, if any occur, a mechanism is in place to ensure that the issue is investigated and resolved.

**Recommendation: All types of coating defects, should be defined within the contract, along with the correction procedure.**

# 4 Summary

The structural boundaries of ballast tanks form a significant part of a tanker hull's primary structure and effective ballast tank coatings are necessary to maintain the integrity of the ship's structure. Poor coating standards leading to increased corrosion creates increased maintenance and cost implications for the ship owner.

The gap analysis results highlight that the TSCF guidelines generally provide more detailed guidance than PSPC and in some places sets higher standards.

In-service experience of applying current PSPC guidelines have highlighted several aspects of the guidelines which could be improved in future revisions in order to be more certain of achieving a 15 year lifetime coating performance in all areas of a ballast tank:

- Surface preparation for block joints.
- Quality assurance for abrasives.
- Stripe coating procedures.
- Availability of coatings for non-standard areas.
- Guidance on the use of block holding primers.
- Maintenance of environmental conditions - storage, transportation, painting and curing.
- Representative test procedures for approving paints.
- Painter qualifications.
- Defect resolution.

# Appendix 1
# Gap Analysis Data

| Item | GUIDELINES for Ballast Tank Coating Systems and Surface Preparation (TSCF) | IMO Resolution MSC. 215(82) Performance Standard for Protective Coatings for Dedicated Seawater Ballast Tanks in all Types of Ships and Double-Side Skin Spaces of Bulk Carriers - | Other relevant recognized standard IACS UI SC 223 ISO 16145-1 | Gap | Comment |
|---|---|---|---|---|---|
| Design Life | Three different coating design life specifications have been established and are presented as follows:<br>**TSCF-10 for minimum of 10 years**<br>**TSCF-15 for minimum of 15 years**<br>**TSCF-20 for minimum of 25 years**<br><br>*Part 2-1, 1 General (Page 15)* | This Standard is based on specifications and requirements which intend to **provide a target useful coating life of 15 years**, which is considered to be the time period, from initial application, over which the coating system is intended to **remain in "GOOD" condition**<br>*4 Coating standard, 4.1 Performance Standard* | | No | |
| Design consideration to erection joint | Positions and number of block erection joints should be optimized wherever possible to reduce any post erection coating work to the minimum.<br>*Part 2-1, 2 Planning (Page 16)* | | | Yes | Block joints are a notable origin of coating defects. |
| Rolled profile | The use of rolled profiles is preferred.<br><br>*Part 2-1, 2 Planning (Page 16)* | .2. the coating performance can be improved by adopting measures at the ship design stage such as reducing scallops, using | | No | |

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|---|---|---|---|---|---|
| | | rolled profiles, avoiding complex geometric configurations and ensuring that the structural configuration permits easy access for tools and to facilitate cleaning, drainage and drying of the space to be coated; and<br>*3. General Principles,* | | | |
| Job-specifications (working procedure) | Job-specification shall be prepared, and shall clearly explain the sequence of main events, inspection hold points, production hold points, acceptance criteria and what the consequences of non-conformance will be. The job-specification shall be developed by the Builder. The document shall then **be reviewed** by all parties: Shipyard, Owner, Contractor and Paint Manufacturer.<br><br>*Part 2-1, 2 Planning (Page 16)* | 3.2. Inspection of surface preparation and coating processes **shall be agreed upon** between the shipowner, the shipyard and the coating manufacturer and **presented to the Administration** for review. The Administration may, if it so requires, participate in the agreement process. Clear evidence of these | | No | |

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| | | inspections shall be reported and be included in the Coating Technical File (CTF)<br>*3. General Principles* | | | |
| Planning<br>- Schedule | The Builder shall prepare a detail work schedule outlining when and where all major coating work shall take place.<br>*Part 2-2 2.1 (Page 41)* | | | Yes | Covered by other requirements. |
| Planning<br>- Pre-Job conference | Before any steel fabrication commences, a Pre-Job Conference shall be arranged by the Builder with all parties present. This is to ensure that there is full and complete understanding by all parties of the corrosion protection process and Standards.<br><br>*Part 2-2 2.4 (Page 41)* | 3.4.1. 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 shall be documented in the Coating Technical File (CTF), and the Coating | | No | |

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|---|---|---|---|---|---|
| | | Technical File shall be reviewed by the Administration. *3. General Principles, 3.4 Coating Technical File* | | | |
| Planning - in-situ | For the 15 and 25 year design life specifications it is preferable that the surface preparation and full coating system is applied in-situ. *Part 2-2 2.6 (Page 41)* | | | Yes | Ability to control environment can minimise potential adverse effects on coating system. |
| Coating material storage | All coating material shall be stored dry in a climatically controlled environment at a temperature ideal for the coating material. Paint stored onboard or at the work site shall be kept inside climatically controlled containers. *Part 2-2 4.14 (Page 43)* | | | Yes | Dependent on paint supplier's requirements. |
| Coating Specification for outfitting in tank | **Any metallic equipment to be installed in these tanks,** unless otherwise agreed with Owner, **shall be treated in the same manner and to the same standard as the surrounding surfaces.** *Part 2-1, 2 Planning (Page 16)* | 4.3.2. It is **recommended** that this Standard is applied, **to the extent possible**, to those portions of permanent means of access provided for inspection not integral to | Reference is made to the non-mandatory MSC/Circ.1279 "Guidelines for corrosion protection of permanent means of access arrangements", adopted by MSC 84 in | Yes | PSPC guidance not as stringent as TSCF. |
| | All the metallic surface areas in these tanks, including CRA (corrosion resistant alloys), and | | | Yes | PSPC guidance not as stringent as |

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|---|---|---|---|---|---|
| | galvanize shall be treated and coated the same as the surrounding surface<br>*Part 2-2 2.9 (Page 42)* | the ship's structure, such as rails, independent platforms, ladders, etc. **Other equivalent methods of providing corrosion protection for the non-integral items may also be used,** provided they do not impair the performance of the coatings of the surrounding structure. Access arrangements that are integral to the ship structure, such as increased stiffener depths for walkways, stringers, etc., are to fully comply with this Standard.<br><br>4.3.3. It is also **recommended** that supports for piping, measuring devices, etc., | May 2008.<br><br>*IACS UI SC223 Page 6* | | TSCF. |
| | All tank covers, bell-mouth and other removal parts shall be coated in the enclosed painting cell(s), and be installed only after completion of the coating of respective surface. Ample protection to be provided to prevent damage to newly applied coating on these individual parts and tank surfaces.<br>*Part 2-1, 2 Planning (Page 16)* | | | Yes | PSPC guidance not as stringent as TSCF. |
| | Coating to be applied over stainless steel or other corrosion resistant alloys (CRA) shall be confirmed not to contain or produce any components that under any possible in-service conditions are hazardous to the CRA.<br>*Part 2-2 4.13 (Page 43)* | | | Yes | PSPC guidance not as stringent as TSCF. |
| | Galvanized surface s shall be grit swept to remove the entire outer surface, yield a roughened surface with a profile in excess of 30 microns, and be coated the same as surrounding surfaces immediately after the surface preparation.<br>*Part 2-2, 5.36 (Page 49)* | | | Yes | PSPC guidance not as stringent as TSCF. |

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|---|---|---|---|---|---|
| | | be coated in accordance with the non-integral items indicated in 4.3.2.<br><br>*4 Coating Standard, 4.3 Special Application* | | | |
| Under Bell Mouth | Areas under bell-mouths should have extra protection by reinforced coating or coating of increased thickness. Coating thicknesses are however to be within the manufactures specified limits<br>*Part 2-1, 2 Planning (Page 16)* | | | Yes | Notable source of corrosion if not adequately protected. |
| Coating selection<br>- Service Temp. | When considering service temperatures the following guide may be generally applied, particular trades, requiring more elevated temperatures, would require special consideration:<br>**Continuous 80 Deg. C for crude oil tankers and**<br>**85 Deg. C for Product Carriers**<br>**Continuous 95 Deg. C for Chemical Parcel Tankers**<br>*Part 2-1, 4 Coating selection (Page 20)* | The selection of the coating system shall be considered by the parties involved with respect to the service conditions and planned maintenance. The following aspects, among other things shall be considered :<br>.1 **location of space relative to heated surfaces**; | | No | |

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|---|---|---|---|---|---|
| | | *4.4 Basic Coating Requirements, Table 1, 1.1* | | | |
| | The Manufacturer is to provide written confirmation that the coating can accept the temperatures to which it will be exposed during service.<br>Part 2-2, 4.8 (Page 42) | Coating manufacturers shall have products with documented satisfactory performance records and technical data sheets<br>*4.4 Basic Coating Requirements, Table 1, 1.1* | | No | |
| | Coatings for application underneath sun-heated decks **or side shell plating,** or on bulkheads forming boundaries of heated cargo or fuel oil spaces shall be able to withstand constant or repeated heating without becoming brittle.<br>Part 2-2, 4.9 (Page 41 and 42) | 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.<br>*4. Coating Standard, Table 1, 1 Design of coating system* | | No | |
| Coating | Identification of the coating selected | | | Yes | Testing paint |

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| selection - Identification | throughout the process must be achievable and suitable product identification standard is presented in Appendix 3. … Random sampling of the material applied shall be carried out on selected coating batches – at least one sample per coating type per ship coated. Samples should be "fingerprinted" to confirm that no modifications have been made; ….<br>*Part 2-1, 4 Coating selection (Page 21)* | | | | chemistry very useful in verifying paint quality. Notable omission in PSPC. |
| Coating selection - Technical Assistance | The manufacturer shall also be capable of rendering adequate technical assistance.<br>*Part 2-2, 4.4 (Page 42)* | The manufacturers shall also be capable of rendering adequate technical assistance.<br>*Table 1, 1.1 Selection of coating system* | | No | |
| Coating test | The Coatings Manufacturer shall confirm, in writing, that the coating to be used, as formulated, has been tested and that it has passed all necessary testing criteria. All test data to be provided, on request, to the Owner.<br>*Part 2-2, 1.3 (Page 41)* | Results from prequalification tests (table 1, paragraph 1.3) of the coating system shall be documented and a Statement of Compliance or Type Approval Certificate shall be issued if found satisfactory by a third | | No | |

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|---|---|---|---|---|---|
| | | party, independent of the coating manufacturer. *5. Coating System Approval* | | | |
| Coating selection - Color | Different distinct colours are **to be available**. The first coat shall have a color that differs from the colour of the treated surface (such as red tinted or aluminum pigmented). This is to ensure that the coating effectively covers the previous coat. The final coat shall be in a light colour to assist inspection *Part 2-1, 4 Coating selection (Page 21)* | A multi-coat system with each coat of contrasting colour is **recommended**.<br><br>The top coat shall be of a light colour in order to facilitate in-service inspection. *4. Coating Standard, Table 1, 1.2 Coating Type* | | Yes | |
| | Contrasting colours are to be used for stripe and full coats and the first coats are to be in a contrasting colour to the steel substrate or intact shop primer (or BHP if used). The final coat is to be of a light colour. *Part 2-2 4.11 (Page 43)* | | The colour of the stripe coating can be decided by the shipyard in accordance with the recommendation of the coating manufacturer. *ISO 16145-1, 6.4.2.2.5* | Yes | Important for ensuring adequate stripe coating. |
| Salt | Salt contamination is the major concern ….. | **≤ 50 mg/m2** of sodium | | No | |

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| contamination | Limits on salt contamination should be **maximum of 30 mg/m2** Cl.<br>*Part 2-1, 5 Steel Surface Preparation (Page 22)* | chloride.<br><br>*4 Coating Standard, 4.2 Basic Coating Requirements, Table 1, 2.2 Water soluble salt limit equivalent to NaCl* | | | |
| | All surface shall have a salt content of less than 30 mg/m2 (as chloride) by ISO 8502-9, and be grit/shot or shot blasted to Sa 2 1/2 by ISO 8501-1 to a profile depth range of 30-75 microns, ISO8503-1 and 2, or as recommended by the coating manufacture..<br>*Part 2-2, 5.4 (Page 43)* | Sa 2½; with profiles between 30-75 µm<br><br>*4 Coating Standard, 4.2 Basic Coating Requirements, Table 1, 2.1 PSP Blasting and Profile* | | No | |
| Pre-construction primer | The pre-construction primer shall be of **ethyl zinc silicate** type compatible with the main coating system approved by the Owner and the Coating Manufacturer.<br>*Part 2-2, 5.5 (Page 43)* | **Zinc containing inhibitor free zinc silicate based or equivalent.**<br>Compatibility with main coating system shall be confirmed by the coating manufacturer.<br>*Table 1. 2.3 Shop Primer* | | No | |
| | The Builder and/or their contractor | The cleanliness of the | In cases where an | No | |

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| | continuously monitor and inspect the pre-construction primer application process.<br>Part 2-25.8 (Page 43) | steel surface shall be monitored in the shop-primer application process<br>*6 Coating inspection requirements, 6.2 Inspection Items* | automatic process for application of shop primer is used, there should be means to demonstrate compliance with PSPC through a Quality Control System, which should include a monthly test.<br><br>Procedure for review of Quality Control of Automated Shop Primer plants<br><br>*IACS UI SC223 Page 14* | | |
| Block stage holding primer | A BHP should not be used for a TSCF 25 year coating design life system.<br>*Part 2-1, 5 Steel Surface Preparation (Page 25)* | | | Yes | |
| | A block stage holding primer can be used for a TSCF 10 and 15 year coating life,<br>*Part 2-2, 5.37 (Page 49)* | | | Yes | Maybe acceptable for PSPC as it is for 15 year life, however some form |

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| | | | | | of guidance would be useful. |
| Contractor Requirements | It is recommended that the Owner approves contractors for the coating operation. A minimum requirement for such approval is that the Contractor shall demonstrate that: …<br>*Part 2-1, 5 Steel Surface Preparation (Page 26)* | | | Yes | Contract is with main shipyard and responsibility for sub-contractors lies with them. |
| | All contractors used by the Builder for corrosion prevention system applications must be pre-qualified and approved by the owner.<br>*Part 2-2, 4.15 (Page 43)* | | | Yes | Contract is with main shipyard and responsibility for sub-contractors lies with them. |
| Stripe Coat | The first stripe coat is to be applied to the prepared steel to ensure suitable penetration into the substrate.<br>*Part 2-1, 6 Stripe Coating (Page 26)* | Stripe coating is painting of edges, welds, hard to reach areas, etc., to ensure good paint adhesion and proper paint thickness in critical areas.<br>*2. Definition, 2.11 Stripe Coat* | A stripe coating is a coating that is applied so as not to leave an uncoated part or give proper dry film thickness and ensure good adhesion in the weak part such as edges, welds, and parts which are difficult to access.<br>*ISO 16145-1, 6.4.2.2.1* | Yes | Different definitions. |
| | Striping shall be given to all welds, edges, | There shall be a | Stripe coats should be | Yes | Wording not clear, |

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| | corners, bolts, scallops, rat holes, lighting holes, bulb bars and all awkward to paint areas. Stripe coat by brush shall precede each coat including the first. Stripe coating shall be done by brush in a normal "stipple-and-level" manner, extending 50mm on either side of the weld or edge. Pressure feed brushes can be used.<br>*Part 2-2, 6.11 (Page 50)* | minimum of two stripe coats and two spray coats, except that the second stripe coat, by way of welded seams only, may be reduced in scope where it is proven that the NDFT can be met by the coats applied, in order to avoid unnecessary over-thickness. | applied as a coherent film showing good film formation and no visible defects. The application method employed should insure that all areas that require stripe coating are properly coated by brush or roller. A roller may be used for scallops, ratholes etc., but not for edges and welds.<br>*IACS UI SC223, Page 13*<br><br>A stripe coating with a minimum of two coats is required in the welding bead and edge part, and<br>one coat (first or second) of stripe coating may be | | order of painting can be better defined, best practice equipment needs to be clearly defined if it has a notable impact. |

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| | | | omitted in order to avoid excessive dry film thickness on the welding bead if the NDFT is satisfied. One coat (first or second) of stripe coating omitted shall be described in detail in the coating technical file (CTF). *ISO 16145-1, 6.4.2.2.3*<br><br>General stripe coating standards for each part are shown in Table 4. *ISO 16145-1, 6.4.2.2.6 (Refer to attachment)* | | |
| Dew Point | The condition control shall be such that the dew point is always at least 3 C below the actual steel substrate temperature at all times during the painting application and final curing phases. *Part 2-1, 6.2.2 Dew Point Requirements (Page 30)* | Coating shall be applied under controlled humidity and surface conditions, in accordance with the manufacturer's | | Yes | PSPC guidance more relaxed than TSCF. This must be backed up by paint manufacturer's requirements. |

<table>
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<tr><td rowspan="2"></td><td>Part 2-2, 6.17 (Page 50)</td><td rowspan="3">specifications. In addition, coating shall not be applied when:<br>.1 the relative humidity is above 85%; or<br>2 the surface temperature is less than 3°C above the dew point.<br>4.4 Basic Coating Requirements, Table 1, 4.2 Environmental Conditions</td><td></td><td></td><td></td></tr>
<tr><td>… The minimum surface temperature is not, however, to be lower than +10 Deg.C. for the 15 and 25 year design life.<br>Part 2-2. 6.13 (Page 50)</td><td></td><td>Yes</td><td></td></tr>
<tr><td>Humidity</td><td>The humidity (Rh) inside the spaces shall not exceed 60% until all coating is applied and cured. …<br>Part 2-2, 6.15 (Page50)</td><td></td><td>Yes</td><td></td></tr>
<tr><td rowspan="2">Extraction Ventilation</td><td>Extraction ventilation shall be maintained at all times during coating application/dry and cure times to ensure that the condition inside tanks is below 10% LEL at all times.<br>Part 2-1, 6.2.3 Extract Ventilation (Page 30)</td><td rowspan="2">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.</td><td></td><td>Yes</td><td>TSCF more specific, but “adequate ventilation” is acceptable.</td></tr>
<tr><td>Table 2:
<table>
<tr><td colspan="3">Minimum Volume Requirements:</td></tr>
<tr><td>Tank Volume M3</td><td>Dehumidified air supply m3/hr</td><td>Extraction Ventilation m3/hr</td></tr>
<tr><td>100</td><td>1000</td><td>750</td></tr>
<tr><td>500</td><td>2500</td><td>2000</td></tr>
</table></td><td></td><td>Yes</td><td></td></tr>
</table>

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|---|---|---|---|---|---|
| | <table><tr><td>1000</td><td>4000</td><td>3000</td></tr><tr><td>2000</td><td>8000</td><td>6000</td></tr><tr><td>4000</td><td>10000</td><td>7500</td></tr><tr><td>8000</td><td>16000</td><td>12000</td></tr><tr><td>16000</td><td>30000</td><td>22000</td></tr><tr><td>32000</td><td>50000</td><td>38000</td></tr><tr><td>64000</td><td>64000</td><td>48000</td></tr><tr><td colspan="3">Overpressure to be assured at all times to prevent ingress of contaminated air or dust into the tank being treated</td></tr></table> | *4.4 Basic Coating Requirements, Table 1, 4.1 Ventilation* | | | |
| | The ventilation volume output shall be near to 75% of the input volume of dehumidication unit to ensure proper extraction whilst maintaining a permanent positive balance at all times inside the tank.<br>*Part 2-2, 6.20 (Page 55)* | | | Yes | |
| Thinning | On site modification of the coating by thinning is **normally not required nor recommended.** Controlled paint storage conditions and "in-line" heaters on the spray hose are the preferred methods to assist in viscosity reduction.<br>*Part 2-1, 6.3.1 Thinning (Page 32)* | Thinner **shall be limited** to those types and quantities recommended by the manufacturer.<br><br>*4.4 Basic Coating Requirement, Table 1, 1.5 NDT* | | Yes | Subject to manufacturer's recommendations. |
| | If thinning is unavoidable required the Coatings Manufacturer's representative must be contracted in each case to confirm that the | | | Yes | |

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|---|---|---|---|---|---|
| | proper thinner is sued and only in appropriate amounts.<br>*Part 2-2, 6.25 (Page 55)* | | | | |
| Paint hose | It is strongly recommended that the same paint hose is used for a particular coating type at all times to keep spray application problems to a minimum.<br>*Part 2-1, 6.3.3 Equipment and Pressure (Page 33)* | | | Yes | Adequate cleaning of hoses and not mixing paints should be part of shipyard's quality procedures. |
| | Using the pump the paint hoses shall be flushed with the thinner for at least 30 minutes before the mixing of the paint starts to ensure that any foreign residue is removed from the system and the pump.<br>*Part 2-2, 6.30 (Page 55)* | | | Yes | |
| Steel Surface Preparation | Steel plates shall be clean and free from defects such as, but not limited to, mill-roller inclusions, de-lamination, projections, etc. Any defects to be corrected before the plate enters the pre-construction priming process. Further, the steel plate shall not be corroded beyond ISO 8501-1: 1988 rust grade B, and be free from pitting.<br>*Part 2-2, 5.1 (Page 43)* | | | Yes | |
| | Steel plate shall be free from water soluble | | | Yes | |

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| | contamination, grease, oil and other foreign matter.<br>*Part 2-2, 5.2 (Page 43)* | | | | |
| Pre-cleaning | Pre-washing, where required, shall always be carried out **shortly before secondary surface preparation begins**, unless the builder can provide clear evidence that the salt requirement in this specification will always be met without such washing<br>*Part 2-2 5.16 (Page 44)* | Water soluble salts limit equivalent to NaCl **after blasting/ grinding ≤ 50 mg/m2 of sodium chloride.**<br><br>*Table 1, 3.6 Secondary Surface Preparation* | | Yes | TSCF provides more comprehensive guidance, but salt limits are equivalent. |
| | The pre-washing shall be done in accordance with SSPC SP 1. A final rinse shall be done using clean potable water (maximum 400 micro S/cm conductivity) under high pressure (typically 150 bar). All puddles shal be removed during washing to ensure that contamination is not re-deposited.<br>*Part 2-2, 5.17 (Page 44)* | | | Yes | |
| | The maximum amount of residual water miscible salt after washing shall be **30 mg/m2 Cl**, where CL = Chloride, measured and calculated in accordance with ISO 8502-9.<br>*Part 2-2, 5.19 (Page 44)* | | | Yes | |

<table>
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<tr><td>Secondary Preparation</td><td>The abrasive used for secondary surface preparation shall be inert clean garnet or mineral slag and comply to the requirements. Part 2-2, 5.21 (Page 47)
<table>
<tr><td>Parameter</td><td>Value</td><td>Standard</td></tr>
<tr><td>Conductivity</td><td>150 micro S/cm, max</td><td>ASTM D4940</td></tr>
<tr><td>Chloride</td><td>15 ppm, max</td><td>Titration</td></tr>
<tr><td>Hardness</td><td>7 Mohs, min</td><td>ASTM E384-89(1997)</td></tr>
<tr><td>Oil</td><td>None</td><td>Vial Test</td></tr>
<tr><td>Cu</td><td>Max 0.01 %</td><td>No scrap process Cu-slag shall be used, only Cu-slug confirmed as refined ore tye</td></tr>
<tr><td>Dust</td><td>None</td><td>Sieve Test</td></tr>
<tr><td>Inclusions</td><td>None</td><td>Visual</td></tr>
<tr><td>Ph</td><td>Neutral 6.5-7 pH</td><td></td></tr>
</table></td><td></td><td></td><td>Yes</td><td>Guidance to minimise use of inappropriate abrasives is considered useful in maintaining quality.</td></tr>
</table>

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| | Moisture: Max. 0.5 % by weight | | | | |

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| | Copy of quality certificates submitted with each batch of the abrasive supplied, shall be kept on side and accessible to all parties upon request. *Part 2-2, 5.25 (Page 47)* | | | Yes | |
| | All compressors shall be tested daily (e.g. "Blotter Test") to confirm that they do not introduce oil, or other contamination, into the compressed air. Water traps shall be used to ensure the compressed air is dry. *Part 2-2, 5.30 (Page 47)* | | | Yes | |
| Secondary Preparation - Surface profile/Grit blasting | Grit blasting shall produce a surface profile depth of 30-75 micron or profile depth **as required for a specific coating**, ISO 8503-Part 2. *Part 2-2, 5.31 (Page 49)* | In case of full or partial blasting 30-75 µm, **otherwise as recommended by the coating manufacturer** *Table 1, 3.4 Profile Requirement* | | No | |
| Secondary Preparation - Surface profile / Power tooling | Where surfaces are cleaned/prepared by power tools a surface roughness of at least 25 microns is to be achieved. *Part 2-2, 5.34 (Page 49)* | | | Yes | |
| Secondary Preparation - Vacuum cleaning | All surfaces shall be vacuum cleaned to remove all residual dust. The absence of loose dust contamination shall be confirmed to be **below rating "1"** by ISO 8502-3. | Dust quantity rating "1" for dust size class "3", "4" or "5". **Lower dust size classes to be** | | Yes | Minor differences. Also subject to paint system requirements. |

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| | *Part 2-2, 5.32 (Page 49)* | **removed if visible on the surface to be coated without magnification.** *Table 1, 3.5 Dust* | | | |
| Secondary Preparation - Grade | For **design life of 10 years** cleaning to ISO 8501 Sa 2.5 shall be carried out for damaged areas and welds. For areas with intact primer a light gritblast shall be carried out to ISO8501 Sa 1. *Part 2-2, 5.33 (Page 49)* | Sa 2½ on damaged shop primer and welds.<br><br>Sa 2 removing at least 70% of intact shop primer, which has not passed a prequalification certified by test procedures in 1.3. If the complete coating system comprising epoxy-based main coating and shop primer has passed a pre-qualification certified by test procedures in 1.3, **intact shop primer may be retained** provided the same epoxy coating system is used. The retained shop primer | Methods such as, but not limited to UHP Water Jetting may be considered for Secondary Surface Preparation, where it can be demonstrated that the surface conditions specified by PSPC Table 1, Section 3 can be achieved before the application of the main coatings. Usually, the fillet welding on tank boundary watertight bulkhead is left without coating on block stage (because not yet be leakage tested), in which case | No | |

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| | | shall be cleaned by sweep blasting, high-pressure water washing or equivalent method. *Table 1, 3.2 Surface Treatment* | it can be categorized as erection joint ("butt") to be power tooled to St 3. *IACS UI SC223, Page 16* | | |
| Coating Application | Temporary gratings for cleaning of footwear shall be provided in way of entrance hatches to all enclosed spaces worked in, and "over-shoes" shall be used when entering such spaces. *Part 2-2, 6.2 (Page 49)* | | | Yes | Useful guidance, but should be covered by yard's procedures. |
| | Wet coating thickness should be checked during application *Part 2-2, 6.8 (Page 50)* | | Wet film thickness shall be regularly checked during application for quality control by the Builder. PSPC does not state who should check WFT, it is accepted for this to be the Builder. *IACS UI SC223, Page 13* | Yes | |
| | Accumulated dry-spray dust should not be overcoated but removed before further painting. | Surface contaminants such as rust, grease, | | No | |

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| | *Part 2-2, 6.9 (Page 50)* | dust, salt, oil, etc., shall be removed prior to painting with proper method according to the paint manufacturer's recommendation. *Table 1, 1.4 Job Specification* | | | |
| Erection Joint-up Areas | Vacuum blasting is the preferred method of treatment for all erection welds for all design life specifications. *Part 2-1, 6.5 Erection Joint-up Areas (Page 33)* | | | Yes | Vacuum-blasting considered useful tool to achieve Sa2.5 in confined spaces. |
| Erection Joint-up area | Where the coating is applied at block stage, the erection join-up areas shall be taped for a distance of at least 50mm from the plate edge after surface preparation. *Part 2-2, 2.7 (Page 2.7)* *Part 2-2, 6.40 (Page 56)* | | | Yes | TSCF guidance applicable for blasting which is not covered by PSPC. |
| Thickness measurement | Dry film thickness test shall be carried out after each coat, not just at the end of the application, by using appropriate thickness gauges. *Part 2-2, 6.34 (Page 56)* | Dry film thickness shall be measured after each coat for quality control purpose and the total dry film thickness shall be confirmed after completion of final coat, | | No | |
| | Spot thickness measurements shall be carried out in accordance with the procedure outlined in SSPC PA2. Measurement should also be | | | No | |

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| | taken at edges to confirm stripe coating is sufficient. …<br>Part 2-2, 6.36 (Page 56) | using appropriate thickness gauges<br><br>*4.4 Basic Coating Requirement, Table 1, 4.3 Testing of coating* | | | |
| Seawater Testing | All tanks shall be filled with seawater (or potable water where relevant) for at least 48 hours, then emptied, drained and opened for a tank final inspection. This is normally done during or after sea-trials. If no defects are found the tank shall be immediately closed and remain so until delivery to prevent damages.<br>*Part 2-1, 8.1 Seawater (or water) testing (Page 33)*<br>*Part 2-2, 7.1* | | | Yes | Covered by other requirements. |
| Defects found during tank final inspection | Blistering is to be considered a serious defect.<br><br>Due to the serious nature of blistering remedial work is to be undertaken…<br><br>*Part 2-1, 8.2 Defects found during tank final inspection (Page 34)* | | | Yes | Lack of defect resolution is unacceptable in PSPC. |
| | Blistering prior to delivery must be considered to be a serious defect and as such would | | | Yes | |

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| | constitute an automatic rejection.<br>*Part 2-2, 7.2 (Page 58)* | | | | |
| | After the repairs have been concluded a new Tank Final Inspection shall be carried out and the tank closed immediately after.<br>*Part 2-2, 7.4 (Page 58)* | | | Yes | |
| Guarantees | The principal reason for the guarantee is to give the owner a limited but comprehensive assurance for a defined period.<br>…<br>Guarantee considerations may include:<br>- Minimum period of guarantee.<br>- Guarantee underwritten by external insurance.<br>- Guarantee to define extent of cover e.g. complete cost to reinstate coatings, plus off-hire costs.<br>- How levels of breakdown are defined – not necessarily as percentage of the tank total surface are a but better to consider breakdown associated with individual subareas.<br>- Typical/distribution of defects e.g. general scattered spot breakdown, whist below the minimum surface area breakdown to | | | Yes | Not covered by PSPC, but covered by contract between owner and shipyard. |

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| | initiate guarantee procedure, would nevertheless require a complete re-blast.<br>- Type of breakdown covered should not be limited to rust only. Defects such as : blistering, cracking, lack of adhesion to substrate or in between coats , brittleness insufficient curing etc. should also be covered.<br><br>It is recommended that the Builder, their Contractor and the Coating Manufacturer jointly provide the guarantee to the Owners in order that all of the involved parties have a vested interest toward the provision of good quality work and products.<br><br>*Part 2-1, 12 Guarantees (Page 38,39 and 40)* | | | | |