BALLAST TANKS

AN OVERVIEW OF THE TSCF GUIDELINES FOR BALLAST TANK COATING SYSTEMS AND SURFACE PREPARATION

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ABSTRACT

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The paper presents an overview of the TSCF's work on the corrosion protection of salt water ballast tank structures and the development of guidelines specific to addressing the use of coating systems for new-building projects and effective maintenance for existing ships.

The guide covers the main aspects of surface preparation, paint selection, application and inspection standards establishing the principles needed to achieve a successful coating service life whether this is for new-building or existing ship applications.

To assist in the specification of corrosion protection systems for new-building projects guidance on the content of a coating system specification is given complete with three "Design Life Specifications" which identify the standards required in order to achieve service lives of 10, 15 and 25 years.

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1. INTRODUCTION

It should not be surprising that for an interest group concerned primarily with steel ship structures the subject of corrosion is a recurring feature of TSCF activities and indeed many excellent papers have been presented on this and related subjects at past Shipbuilder's meetings.

Typical examples of the TSCF work on corrosion can be found in papers such as the 1987 paper "Corrosion in cargo and ballast tanks, causes and prevention"[1] by Chevron and more recently, Shell's "Corrosion Protection Systems for New Build Tankers"[2], in 1992. These works clearly identify the benefits of paint coatings and a common theme within the papers conclude that cost effective maintenance throughout a ship's life is greatly dependent on the application and maintenance of paint coatings.

From the TSCF's perennial concern with the design and maintenance of efficient structures these earlier papers have thus acknowledged the primary importance of effective coatings in prolonging the life of tanker structures and reducing life time repair costs. Having rigorously established the importance of coatings for our industry Shell's paper in 1992 examined the prime issues to be considered, identified "Critical Areas of Corrosion", "Types of Corrosion Protection", and offered advice on quality standards for coating application. The paper also introduced aspects of, planning, supervision and guarantees, important foundations and the ultimate conclusion to the whole process.

With this established history for the TSCF's involvement with corrosion and coating issues the TSCF are able to present to the industry our further studies on the subject. This paper's remit is to present the TSCF's "Guidelines For Ballast Tank Coating Systems and Surface Preparation"[3]. As its name implies the document is aimed at corrosion control for ballast spaces acknowledging the industry's specific concerns for these important spaces.

The "Guidelines" are a distillation of the knowledge and experiences of all its members and it is hoped that the document will become a valuable source of best practice and procedures which will ultimately enhance the efficiency and safety of the world's fleet, the primary aim of the TSCF.

2. THE BROADER PERSPECTIVE

We are all well aware of the tanker industry's importance to the Global economy and the fact that the contribution of our industry to our daily lives is often obscured by a few controversial episodes. Unfortunately it is these few incidences which tarnish our industry with the ingenuous external view that we cannot be trusted to moderate our own industry. This needs to change and it is imperative that we should not only continually strive to achieve better standards for the world's fleet as a whole but just as importantly be seen to be doing it.

Understandably ,Regulatory bodies, prompted by the public's image of the industry are often driven to act in way that we cannot anticipate. If the industry is not to be thrown continually from one step change in our business to another then we must continually develop and promote our activities to the benefit of all.

At the time of writing it is only a few months since a pollution incident off the coast of France has required the industry once again to examine the risks associated with oil transportation, in this instance acutely focusing on structural performance.

Unfortunate as this casualty was, it is timely to be reminded that opinion made public to date identifies that the structural failure originated in way of the ballast spaces.

Although the structural condition of the ballast spaces was a contributory factor leading to the disaster, this paper is not intended to discuss this particular incident. Simplistically it is all too easy to blame this failure on poor maintenance, the simple case of a ship continuing in service without fully accounting for the structural wastage. Here ,however, is a significant illustration of the possible consequences of refusing to acknowledge the true gravity of coating break down and the necessity for carrying out suitable coating repairs early in the ship's life, before significant wastage takes place.

3. AN INTRODUCTION TO THE "GUIDELINES FOR BALLAST TANK COATING SYSTEMS AND SURFACE PREPARATION"

Advice on coating systems, can be found in many standards published world-wide. Standards for coating applications in the ship-building and repair environment have been produced by International and National agencies, Classifications Societies and many learned institutions. The prospect of examining all the codes and specifications is however a daunting task and thus these "Guidelines" have been devised as a key to gain practical access to this valuable information. The references section within the "Guidelines" identifies many key documents which will allow the reader to find suitable documentation for further in depth study if required.

The TSCF "Guidelines" are the conclusion of a vast and wide ranging study, taking the TSCF members' experiences of coating lives and cross referencing these with the various application standards used. Ultimately the data was collated and assessed against the world wide standards and codes establishing best practices. These best practices have been reduced to three specific coating design life specifications. The aim of the design life specifications is to provide a quick and easy reference guide in order to evaluate particular coating systems, the intention being to promote the application of consistent standards. The specifications also allow a clear identification of possible future maintenance requirements highlighting areas that may require particular attention. It should be realised that it is not the TSCF's remit to demand that ships are to be provided with coating systems that do not require maintenance in a ships life. This would be an impossible ideal to promote, within the design life specifications however there should be enough scope for the choice of a system which balances a particular operating profile.

The TSCF guidance is not intended therefore to establish new methods for coating system application but has brought together established methodology and presents them in a practical and hopefully clear and concise approach. The "Guidelines" have thus provided options and information to designers, shipyards and ship-owners but have also been devised as being specific enough to be used as a reference document for shipbuilding repair and maintenance purposes.

Why are we doing this ? :-

- To establish best practise principles and methodology for the specification of paint coating systems.
- To qualify standards proposed against an expected design life of the system.
- To allow an evaluation of a coating standard against future maintenance requirements.

Coating systems play a key role in establishing a ship's level of through life maintenance and the industry should recognise the vital importance in becoming more accountable for these systems of corrosion protection.

4. DEVELOPMENT OF THE "GUIDELINES"

In February of 1995 the TSCF commenced a fact finding project the aim of which was to evaluate members experiences of coating systems and identify parameters associated with achieving long term performance of coating systems.

Under the joint chairmanship of SHELL and MOC two separate work groups one in Europe and one in the USA were established to enable members to discuss their experiences.

It was at the inception of the work group project on "Coating Life" that an outline document was produced to enable the participants in the project to make an evaluation of any corrosion protection system, identifying standard parameters which were to be reported upon. It was the replies to this "discussion document" that have been used as the basis in formulating a set of practical "Guidelines" on coating application. It was also the aim at this time that the “Guidelines” should be available for use in contract discussions with Shipbuilders as a vehicle to provide an increased awareness of the Shipbuilder’s own responsibilities in applying these vital systems correctly.

The discussion document circulated included two separate questionnaires, see Appendix I, designed to gather detailed information on coating application and performance. The first questionnaire dealt with specific vessels and their record of corrosion protection performance, whilst the second was aimed at assessing the general attitude of various Shipyards to the application of protective coatings and records details of facilities available to carry out the coating task.

The stated main objective of the study was :-

> "To complete a survey of experiences on tank coating systems at new-building and in service in order to identify and highlight the key requirements for establishing reliable, long-life corrosion protection systems for water ballast tanks"

In October 1996 an analysis was made of the completed questionnaires. The information compiled covered a variety of shipyards and ship-types. LNG, Chemical tankers products and crude carriers were all represented in the information provided. The information when analysed identified a vast range of experiences but did enable common practices to be identified which had been shown to promote good quality ballast tank coatings. The experiences ranged between 100% blistering within 1 year to systems achieving up to 15 years service with only minor breakdown.

An important observation to be made from the information collected comes from the diversity of the data. The pool of information available does not allow for the grading of specific manufacturers products. This is due to the many variations in the application of each product covering a vast range of combinations ; product/ship type/Shipbuilder/application process and length of service experience.

The benefit of this is that the general sensitivity of paint coating systems to the application processes can be identified on a global basis. This is therefore a highly valuable aspect of the data collection process providing the basis upon which to establish procedures applicable world-wide on a more general basis without being sensitive to a particular manufacturers product.

The major objection to such an experience based study must be that the conclusions are established based on products with varying service lives, i.e. plenty of experience for coal tar epoxy, but less experience in light coloured modified or pure epoxy coatings. It may also be argued that the processes concluded to be the best practices for current products may also not be appropriate for newly developed ones, or for newly developed processes. In these instances the “Guidelines” must be used as the base line from which the newer products can be evaluated. There must be development of new corrosion control products and procedures and the future impact of these products must be recognised. Care must be taken when assessing the performance claims of new products and procedures but understanding the current processes and all the factors required to be considered when specifying a coating system should provide the reader with some support in the decision process.

5. THE TSCF "GUIDELINES FOR BALLAST TANK COATINGS SYSTEMS AND SURFACE PREPARATION"

Having established the TSCF members' past experience, reviewing the mass of codes and standards available and considering possible future Regulatory commitments the need to produce a document bringing together practical advice on ballast tank coatings was seen as a necessity.

The TSCF document consists of three parts. The first is an introduction to the basis of corrosion protection using paint coatings. This part introduces the reader to the fundamentals of coating systems and why they work. The introduction is not an exhaustive exploration of the subject and it is hoped interested readers will develop their knowledge from the list of references made available. The reader is wise however to understand the basic fundamentals of why we need good surface preparation, a knowledge of these basic facts will thus support and explain the recommendations made in the TSCF "Guidelines". Once the basics are established the reader will be in a more suitable position to evaluate their needs against proposed specifications and will allow any decisions on equivalencies to the TSCF recommendations to be made knowledgeably. It should be borne in mind that the TSCF document is intended for guidance in providing a good basis from which to devise an appropriate coating specification for the task required. One important point to be emphasised in Part 1 of the "Guidelines" is the small paragraph on teamwork. It is imperative to establish a good working relation ship between paint supplier, ship builder and inspecting authority in order to produce a successful end result. This working relationship between all parties can only survive if all parties understand the aims of the process they are trying to achieve and consider the main concerns and abilities of each factor in the process, the TSCF "Guidelines" will promote this understanding.

The TSCF document introduces three specific "design life specifications" the basis of which can be used to establish a suitable coating with a desired life expectancy. The TSCF does not guarantee that the coating design lives as specified will be achieved as each application has its own individual application characteristics, but gives all parties the support required to establish an appropriate specification with clearly defined objectives.

Part 2-1 of the "Guidelines" reviews in more detail the individual components that must be relied upon to produce a favourable outcome to the coating process. Subjects are reviewed from planning through to safety and guarantees providing the background detail to items presented in Part 2-2.

Part 2-2 identifies the content and form of a typical building specification and contains the TSCF design life specifications. The design life specifications are designated as TSCF10, TSCF15 and TSCF25. Following these specifications is intended to provide coating systems with life expectancies of not less than 10, 15 and 25 years respectively. Here the life of the coating is considered effective until the coating degrades, by normal wear and tear, to a "POOR" condition as defined by IACS in the Enhanced Survey Program (ESP), degradation being limited to instances of blistering, coating cracking, and detachment – excluding any mechanical or contact damages. For the purposes of establishing the coating life it is assumed that the need and scope of repairs within the design life will be limited to areas where the coating has become mechanically damaged. The TSCF design life specifications are reproduced in Appendix II. For application of these specifications specific guidance is to be taken from the relevant part in the "Guidelines".

Part 3 reviews the special case of in-service maintenance and repair and considers the effectiveness of particular preparation methods.

For new-building projects there is the opportunity to "get it right" first time, for the maintenance and repair world all parties need however to realise the demanding requirements necessary for good coating performance and these are established in this part.

From the experiences of the TSCF it has always been found that appropriate maintenance of ballast tank coatings is a far more cost effective method of ensuring safer structures than relying on steel

work repairs alone. The method chosen to tackle breakdowns is, however, highly dependent on the position and extent of coating breakdowns i.e. leave and make a better job in dock or touch up using riding crew, the economies have to be considered. With this in mind the TSCF "Guidelines" establishes the principles necessary to be considered when balancing the level of coating repairs and how they should be carried out. In service condition monitoring is also discussed.

The "Guidelines" also present in detail inspection and qualification requirements. It is considered that workmanship practices, particularly the training of all workers in the painting process, are issues requiring a level of investigation in themselves. Suffice to say that when contracting for paint coating services it is wise to ensure that all subcontracting parties are known to the purchaser of the services, cutting costs by the use of inadequately trained operators is the first mis-placed step towards poor service.

Appendices to the TSCF document cover such aspects as a review of the current Regulatory environment, cathodic protection, testing and certification of ballast tank coatings, a check list for a coating inspectors duties, definitions and descriptions of terms and a listing of pertinent standards.

6. CONCLUSION

It is hoped that these "Guidelines" will be received in the spirit in which they are intended, that is to enhance the safety and security of our business and promote the quality of the world's fleet.

Returning to the initial comments on the unfortunate incident at the end of last year. We are all aware that there are available very simple solutions to the corrosion of ship structures, appropriate inspection and maintenance procedures being a prime example.

Maintenance and inspection programmes need, however, to be applied consistently and comprehensively to be effective but the main issue must be to ensure that the correct corrosion control system is specified and correctly applied in the first place. It is essential to ensure that our industry continually advances its knowledge and applies technologies in the most beneficial form for its successful future.

7. ACKNOWLEGEMENTS

It must be acknowledged that a significant number of man-hours and resources have been expended by the TSCF membership in order to bring to the industry such a guidance document.

8. **REFERENCES**

1) “Corrosion in cargo and ballast tanks causes and prevention”, presented by Chevron at the TSCF 1987 Shipbuilders meeting.
2) “Corrosion protection systems for new-build tankers”, presented by Shell International Marine Ltd. at the TSCF 1992 Shipbuilders meeting.
3) “Guidelines for ballast tank coating systems and edge preparation”, TSCF 2000.

APPENDIX I
QUESTIONNAIRES

Questionnaire on Water Ballast Tank Coating Systems, Practice and Experience

(complete one questionnaire per ship)

Section 1 - General:

1. Ship Type (Products/crude) ?	
2. Ship Size (dwt) ?	
3. Date of Delivery ?	
4. Builder ?	
5. Number Previous of Owners ?	
6. Hull Number?	
7. Period of Lay Up?	

Section 2 - Tank Summary:

TANK	**FP**	**AP**	**WING P/S 1,2,3**	**Double Side**	**Double Bottom**	**Others**
8. Structural arrangement (flush, stiffened vertically, horizontally, HTS) ?						
9. % of time in ballast						
10. % filling (typical)						
11. Heat adjacent to tank ?						
12. Coating system(maker and product including number) ?						
13. Coating system selected by owner or yard ?						
14. Number of top coats ?						
15. Total DFT?						
16. Type of shop primer applied (maker, product number)?						
17. Was top coat applied at block stage or build stage?						
18. Stripe coat applied? D						
19. Anodes Fitted ?						
20. Anode type (material)?						
2 1. Current density						

Section 3 - Coating Application at Build

22. Standard of primary surface preparation before application of primer (e.g. Sa 2.5 or equivalent) ?	
23. Blast material (grit, sand, shot copperslag, others)?	
24. Standard of secondary preparation of primed surfaces before over-coating (e.g. sweep blast, primer fully blasted, disking, none) ?	
25. Where was secondary preparation and coating application done (Paint shop / outdoors)	
26. Checks for contamination (salt) ?	
27. Standard of preparation in way of erection butts and damaged areas (e.g. blast to Sa 2.5, Vacu-blast to Sa 2.5, blast to Sa 2, power tooling to St 3)	
28. Radius of free edges ?	
29. Extent of supervision during building (owners, yard, manufacturer, combination) ?	
30. Were coating materials tested before application. ?	

Section 4 - Experience with Inspection and Maintenance of New Build Coating System

TANK	**FP**	**AP**	**WING P/S 1,2,3**	**Double Side**	**Double Bottom**	**Others**
31. Frequency of coating inspection						
32. How long was it before coating repair was required						
33. Where did coating breakdown (plating , longitudinals, T stiffs, L stiffs etc.)						
34. How much had to be repaired (% area)						
35. What was the reason for the coating failure						
36. What was the type of coating breakdown (general, blistering edge etc.)						
37. After how many years was steel renewal required						

38. What extent of steel renewal was necessary (weight)						
39. Where was repair action undertaken (e.g. voyage, yard)						
40. What surface preparation method was used in way of coating repair (hydro-blasting inc. pressure, spot blast power tool etc.)						
4 l. How was coating repair supervised (yard, owner, etc.)						
42. What surface prep standards were applied for repair action						
43. What type of coating was used for repairs (hard, soft)						
44. Was coating repair full coat or spot coat						
45. Was tank dry or humid for repair						
46. Was degreasing work in way of repair area						
47. How long before further repair was required						
48. Was repair required in new-build coating or subsequent repair coating						
49. Frequency of inspection after initial repair						
50. Type of breakdown after initial repair						
51.Position of subsequent breakdown						

TSCF1.DOC

Section 5 - Other Information

52. What is your preferred ballast tank coating system today (incl. DFT and number of coats) ?	
53. Do you have any involvement in paint related research projects.?	
54. Opinion on shipyard application/prepartion standards ?	
55. Suggested weaknesses/improvements in current application/preparation standards ?	
56. What are your expectations for service life o your preferred coating (to first repairs, to failure/replacement)?	

TSCF - 1995 **Work Group Project: - "Evaluation of Water Ballast Tank Coating Systems**".

Questionnaire 2 ;- **"Shipyard Facilities and Experiences"**

Q. 1 - Shipyard, location and period of new-building / repair :-

Q.2 - Type of vessels under construction or repair :-

Q.3 - Shipyard facilities available :-

(a) - Initial surface preparation and quality :-

(b) - Blasting Halls, number and quality :-

(c) - Painting Halls, number and quality :-

(d) - Dehumidification equipment for in-situ painting :-

Q.4 - Number of Inspectors involved during Contract :-

(a) - 0wner's Representatives (number and nationality) :-

(b) - Paint Manufacturer's Representatives (number and nationality) :-

(c) - Shipyard QC :-

Q.5 - Inspection frequency :-

Q.6.- Details of Coating System applied to Water Ballast Tanks :-

Q.7. - Special Requirements specified for surface preparation and coating application,

such as :-

(a) - Full blasting / Sweep blasting and percentage :-

(b) - Surface cleanliness (soluble salt, etc) :-

(c) - Staging, lighting and ventilation :-

(d) - Edge grinding, weld slag, etc. :-

(c) - Stripe coating (before or after first coat, between coats, etc) :-

(f) - Independent testing of paint material :-

Q. 8 - Secondary surface preparation (erection joints, damaged areas, etc.) :-

Q. 9 - Quality and training of Shipyard personnel :-

(a) - Blasters :-

(b) - Painters :-

(c) - QC dept. :-

Q. 10 - Particular problems or difficulties during Contract or after delivery :-

APPENDIX II

TSCF COATING DESIGN LIFE SYSTEM SPECIFICATIONS.

TSCF 10: Guide for minimum of 10 years system specification.

Item	Requirement	Comment
Primary surface Preparation:		
Blasting and profile	Sa 2 ½, 30-75 micron	ISO 8501, ISO 8503-1/3
Soluble salt limit	□30 mg/m^2	ISO 8502-9
Pre-construction primer:		
Coating type	Ethyl-zinc-silicate	
Secondary surface preparation:		
Steel condition	Preparation grade P1, one pass edge grinding.	ISO 8501-3
Pre-washing	Recommended	SSPC SP1
Salt limit for secondary S.P.	□30 mg/m^2	ISO 8502-9
Surface treatment	Sa 2 ½ on damaged pre-construction primer and welds, Sa1 on intact pre-construction primer removing 30% of primer.	Block holding primer acceptable.
After erection	Butts & Damages St3	
Profile requirements	As coating requirement	BS 2634
Dust	"1"	ISO 8502-3
Salts after blasting / grinding	□30 mg/m^2	ISO 8502-9
Abrasive inclusions	None	As viewed without magnification.
Painting Requirements:		
Minimum surface temperature	As advised by manufacturer	+10^o C recommended.
Coating pre-qualification	Independent testing	Appendix 4
Thickness requirement	250 mic dft minimum, over the pre-construction primer thickness.	
Coating type	Light colour epoxy	
Number of coats	Minimum one full stripe followed by two full spray coats.	
Anodes:		
Zinc or Aluminium* anodes	As per contract	*Installed in accordance with Class Rules.

Acceptance citeria :

The following shall cause rejection :

1. Excessive sags and runs. Isolated sags and runs, defined as 1 per each 10m^2 maximum is permissible.
2. Pinholes : none allowed.
3. Air bubbles or air bubble craters : none permissible.
4. Low dft (dry film thickness): none permissible.
5. Too high dft : none permissible (see item 1 for only exception).
6. Blistering : none permissible.
7. Lifting or peeling : none permissible.
8. Insufficient dehumidification, heating and/or ventilation : none permissible.
9. Unsafe or poorly erected staging : not acceptable.
10. Poor cleaning, presence of inclusions or invisible contamination in excess of the specification : none permissible.

TSCF15 : Guide for minimum of 15 years system specification.

Item	Requirement	Comment
Primary surface Preparation:		
Blasting and profile	Sa 2 ½, 30-75 micron	ISO 8501, ISO 8503-1/3
Soluble salt limit	□30 mg/m^2	ISO 8502-9
Pre-construction primer:		
Coating type	Ethyl-zinc-silicate	
Secondary surface preparation:		
Steel condition	Preparation grade P2, Three pass edge grinding.	ISO 8501-3
Pre-washing	Recommended	SSPC SP1
Salt limit for secondary S.P.	□30 mg/m^2	ISO 8502-9
Surface treatment	Sa 2 ½ on damaged pre-construction primer and welds, Sa2 on intact pre-construction primer removing 70% of primer.	Block holding primer acceptable.
After erection	Butts Sa 2 ½ & Damages St3	
Profile requirements	As coating requirement	ISO 8503-1/3
Dust	"1"	ISO 8502-3
Salts after blasting / grinding	□30 mg/m^2	ISO 8502-9
Abrasive inclusions	None	As viewed without magnification.
Painting Requirements:		
Minimum surface temperature	As advised by manufacturer	+10^o C recommended.
Coating pre-qualification	Independent testing	Appendix 4
Thickness requirement	300 mic dft minimum	
Coating type	Light colour epoxy	To be qualified by testing
Number of coats	Minimum two full stripe coats followed by two full spray coats.	
Anodes:		
Zinc or Aluminium* anodes	As per contract	*Installed in accordance with Class Rules.

Acceptance citeria :

The following shall cause rejection :

11. Excessive sags and runs. Isolated sags and runs, defined as 1 per each 100m^2 maximum is permissible.
12. Pinholes : none allowed.
13. Air bubbles or air bubble craters : none permissible.
14. Low dft (dry film thickness): none permissible.
15. Too high dft : none permissible (see item 1 for only exception).
16. Blistering : none permissible.
17. Lifting or peeling : none permissible.
18. Insufficient dehumidification, heating and/or ventilation : none permissible.
19. Unsafe or poorly erected staging : not acceptable.
20. Poor cleaning, presence of inclusions or invisible contamination in excess of the specification : none permissible.

TSCF 25 : Guide for minimum of 25 years system specification.

Item	Requirement	Comment
Primary surface Preparation:		
Blasting and profile	Sa 2 ½, 30-75 micron	ISO 8501, ISO 8503-1/3
Soluble salt limit	□30 mg/m^2	ISO 8502-9
Pre-construction primer:		
Coating type	Ethyl-zinc-silicate	
Secondary surface preparation:		
Steel condition	Preparation grade P2, edge grinding to radius.	ISO 8501-3
Pre-washing	mandatory	SSPC SP1
Salt limit for secondary S.P.	□30 mg/m^2	ISO 8502-9
Surface treatment	Sa 2 ½ for full area.	ISO 8501 Block holding primer not acceptable.
After erection	Butts and damages Sa 2 ½	
Profile requirements	As coating requirement	ISO 8503-1/3
Dust	"1"	ISO 8502-3
Salts after blasting / grinding	□30 mg/m^2	ISO 8502-9
Abrasive inclusions	None	As viewed without magnification.
Painting Requirements:		
Minimum surface temperature	Minimum +10^o C	or higher if recommended by coating manufacturer.
Coating pre-qualification	Independent	Appendix 4
Thickness requirement	350 mic dft minimum	
Coating type	Light colour epoxy	To be qualified by testing
Number of coats	Minimum three full stripe coats followed by three full spray coats.	
Anodes:		
Zinc or Aluminium* anodes	As per contract	*Installed in accordance with Class Rules.

Acceptance citeria :

The following shall cause rejection :

21. Excessive sags and runs. Isolated sags and runs, defined as 1 per each 100m^2 maximum is permissible.
22. Pinholes : none allowed.
23. Air bubbles or air bubble craters : none permissible.
24. Low dft (dry film thickness): none permissible.
25. Too high dft : none permissible (see item 1 for only exception).
26. Blistering : none permissible.
27. Lifting or peeling : none permissible.
28. Insufficient dehumidification, heating and/or ventilation : none permissible.
29. Unsafe or poorly erected staging : not acceptable.
30. Poor cleaning, presence of inclusions or invisible contamination in excess of the specification : none permissible.