IMO PSPC implementation and 15 years of target useful coating life

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ABSTRACT

The Performance Standard for Protective Coating (PSPC), adopted by the International Maritime Organization (IMO) Resolution MSC.215(82), became mandatory on 1 July 2008 (contract date of ship's new construction) for dedicated seawater ballast tanks on all types of ships of not less than 500 gross tonnage and for double-side skin spaces arranged in bulk carriers of 150 m in length and upwards. In addition, a new PSPC requirement, stemming from the recent adoption of IMO Resolution MSC.288(87), will become effective 1 January 2013 (contract date of ship's new construction) for the crude oil tanks of oil tankers of not less than 5,000 tonnes deadweight. Both PSPC standards set out a target useful coating life of 15 years, over which the coating is intended to remain in GOOD condition from initial coating application.

The shipyard is responsible for implementing the requirements of the IMO PSPC during new construction. Before new construction starts, a Tripartite Agreement (TPA) on inspection procedures of the surface preparation and coating processes shall be agreed upon and signed by the owner, the shipyard and the coating producer. In addition to the selection of qualified and certified coating inspector(s), quality control of surface preparation, steel work and coating application at every phase of new construction, harmonized with the shipyard's facilities and experience, is to be agreed upon for PSPC compliance. Those are reflected in good TPA and the final Coating Technical File (CTF). This is most important in order to achieve the target useful coating life.

This paper will focus on the key elements relevant to shipyards during new construction that affect the useful coating life. Those elements are the Tripartite Agreement (TPA), qualified coating inspector, primary surface preparation, steel work, secondary surface preparation, erection and coating application condition. The standardization of shipyard new construction processes to the PSPC requirements has the potential for improving the quality of coating, and also provides an opportunity for better control of costs during construction and throughout the service life of the vessel.

Keywords: IMO PSPC; Tripartite Agreement (TPA); Coating Technical File (CTF); Edge grinding.

INTRODUCTION

Corrosion protection gained from the effective application and maintenance of coatings is of great importance to the marine industry. The recent amendment and adoption to the Safety of Life at Sea (SOLAS) regulations by the International Maritime Organization (IMO) in resolutions MSC.216(82) and MSC.291(87) requires the Performance Standard for Protective Coating (PSPC) for specified spaces

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within ships. The SOLAS II-1/3-2 regulation, amended by the IMO Resolution MSC.216(82), became mandatory on 1 July 2008 (contract date of ship's new construction) for the IMO Resolution MSC.215(82) requirement – Performance Standard for Protective Coating (PSPC) for dedicated seawater ballast tanks of all types of ships of 500 gross tons and above and for the double-side skin spaces of bulk carriers of 150m in length and upwards. The International Association of Classification Societies Ltd (IACS) made the PSPC mandatory for oil tankers and bulk carriers contracted on or after 8 December 2006 and built under Common Structural Rules (CSR).

Since the formal implementation of the new standard on 1 July 2008 there have been an increasing number of vessels that must comply with the PSPC. Although the role of the class society, under the PSPC, is primarily that of an auditor whose role is to verify that the standard's requirements are followed by the parties to the Tripartite Agreement, Class societies continue to receive requests to assist in interpreting the IMO PSPC. To promote consistency, Class is also positioned to obtain feedback from industry regarding the application of the new standard. To assist industry, the IACS members may develop Unified Interpretations (UIs) of the IMO PSPC, relating to issues such as the maximum recommended erection joint sizes, the scope of calculating coating damages and the use of power tooling as examples.

The newly adopted SOLAS regulation II-1/3-11, to become effective 1 January 2013 (contract date of ship's new construction), also requires the crude oil cargo tanks of tankers to be coated according to PSPC. This increased PSPC requirement for oil tankers is similar to the requirement currently mandatory for dedicated seawater ballast tanks. Shipyards are expected to implement the same or similar production procedures and quality control procedures to meet both PSPC requirements.

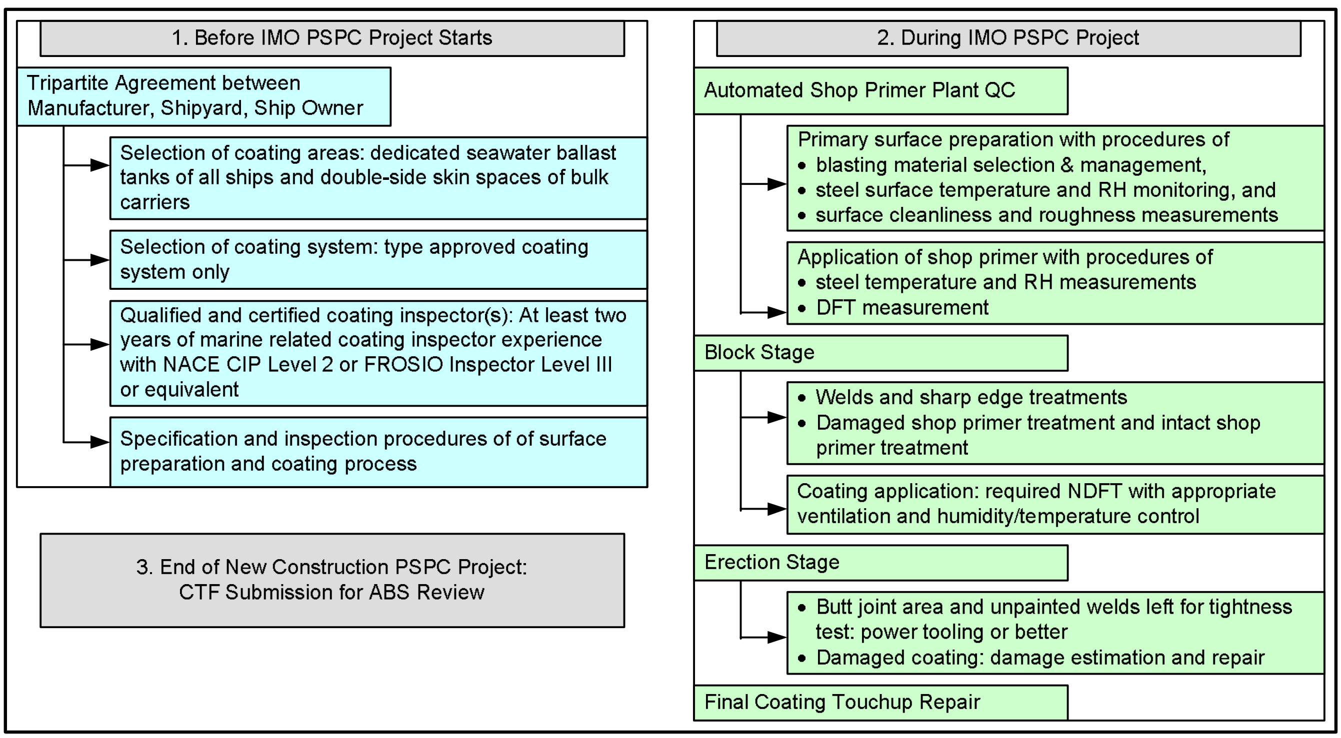


Figure 1 Shipyard PSPC implementation phases during new construction

Figure 1 lists shipyard PSPC implementation phases during new construction. As the many different shipyards in the world have adopted their own quality control systems, the manner in which each yard seeks to comply with the PSPC requirements may vary. The proficient application of coatings in shipyards, consistent with the IMO PSPC requirements, can improve coating performance and potentially reduce the frequency and extent of coating in-service maintenance and repairs. The standardization of shipyard new construction processes to the PSPC requirements has not only the potential for improving the quality of coating, and also provides an opportunity for better controlling costs during construction and throughout the service life of the vessel.

The most important areas, which will affect the PSPC implementation quality, and therefore the target useful coating life, will be discussed in this paper. Those are the Tripartite Agreement (TPA), qualified coating inspector, primary surface preparation, steel work, secondary surface preparation, coating application, erection, coating repairs, onboard in-service maintenance and repair, and the Coating Technical File (CTF).

TRIPARTITE AGREEMENT (TPA)

The IMO PSPC requires that the three parties- the shipyard, the coating producer and the owner, agree on the inspection of surface preparation and coating processes. Reviewed and confirmed by Class, the Tripartite Agreement (TPA) may not alter or deviate from the PSPC, but may be interpreted as appropriate to combine the shipyard's practice and the owner's requirements.

Traditionally, coating specification at shipyards tended to be under-specified, leaving much to be "sorted out" by the participants during the coating process. This is the reason that IMO requires the three parties to agree, before the PSPC project actually starts, on how to meet the PSPC requirements for achieving the target coating life. This agreement is intended to enhance conformity and predictability, and increase productivity. An effective approach to coating also carries the potential of improving the overall cost benefit.

The IMO PSPC provides the reference standards and the TPA needs to define the specific procedures to follow, such as soluble salt measurement procedure, salt cleaning procedure (if applicable), maximum dry film thickness (DFT), "maximum DFT" determination (e.g., average of five (5) readings evenly distributed within a 10 x 10 cm^2, any individual value allowed to deviate from the maximum). This is to avoid any single measurement being misused. The TPA shall include and clarify all of the steps for the entire process. The coating applicator and the coating inspector need to know what the acceptance window is before the project starts.

Storage, transport and other aspects of steels are to be considered, as well as the type of plate cutting, the potential for contamination in the process, and remedies for such contamination. For example, if submerged cutting is used, what is the make-up of the liquid in which the plate is submerged and does it contain inhibitors or other water soluble salts?

There are many more aspects that the parties need to consider. In the following sections, some particular concerns will be identified for the TPA. It is important that the parties take into account as many relevant aspects and concerns as possible and include them in the TPA. Prior to start of the work, the more questions asked with the more clarification given will result in fewer misunderstandings later.

In addition, the three parties need to be in agreement on the spaces to be coated, the coating system selection, and the coating inspector qualification and responsibility.

The TPA should specify that the necessary application records and data are collected in agreed forms. The appropriate summary reports of those data are needed for the Coating Technical File (CTF) as required by the IMO PSPC.

QUALIFIED COATING INSPECTOR

To comply with the IMO PSPC, the inspections shall be carried out by qualified coating inspector(s) certified to NACE (National Association of Corrosion Engineers – NACE International) CIP (Coating Inspector Program) Level 2, FROSIO (the Norwegian Professional Council for Education and Certification of Inspectors for Surface Treatment) Inspector Level III or equivalent. The equivalent coating inspector qualification shall be verified by the Administration or Class society (as a Recognized Organization – RO, acting on behalf of the Administration). It is vital that the coating inspector is not only qualified but has a number of years of marine coating inspector experience in addition to the certification, so that he/she is suited for the task. These requirements are clarified by IACS PR 34 and UI 223, requiring at least two (2) years relevant coating inspector experience in addition to the certification for inspectors tasked with writing and/or authorizing procedures, or deciding upon corrective actions to overcome non-compliances. The logic behind the qualification requirement at IMO was that it is easier for properly experienced and qualified inspectors, due to their professionalism, to work together toward the common goal. Inexperience feeds uncertainly that may harm predictability and productivity.

IACS PR 34 and UI 223 further interpret that the experienced and certified coating inspector may be assisted by an assistant coating inspector who is to be trained to the assigned coating inspector's satisfaction to undertake tasks under the direct supervision of the coating inspector. In this manner, the new, less experienced inspectors in shipyards can gain coating inspector experience. This added interpretation is not expected to result in any deviations from the intended inspection quality from the original IMO PSPC requirement. It is not the intent that the assistant inspector inherits the coating inspector's responsibility.

The National Association of Corrosion Engineers (NACE International) defines the coating inspector's role as that of a quality control technician who is primarily responsible for observing and reporting on technical aspects of the coating project. It is the coating inspector's ultimate duty to enforce the specification and the procedures and to help the parties avoid unnecessary difficulties. It is, however, not the duty of the inspector to release the quality assurance responsibilities of the shipyard, contractor or coating supplier. The tripartite agreement and pre-job meeting should clarify the line of duties.

(a) Paint mixing station (b) DFT measurement and Class verification

Figure 2 Coating inspection for paint mixing, DFT measurement, etc

The qualified coating inspector shall fully understand the coating specification with acceptance criteria and, his / her responsibility and authority, as agreed upon and signed by the three parties. The coating inspector shall frequently consult with the coating producer's representative regarding the requirements of the coating technical data sheets, and verify that those harmonize with the PSPC and the overall intent of the application. He/she must be alert at every coating stage for any quality control issue during surface preparation, mixing/thinning operation, and coating application (Figure 2 for example). In addition to verifying surface preparation and coating application to the specification and standards, the inspector must also be alert to relevant human mistakes that may occur that contribute to premature coating failure. It should be admitted by all parties that the specification and inspection procedures agreed on are not perfect, and they may not cover every possible occurrence during coating work.

Anything not covered in the specification and inspection procedures should be interpreted by the coating inspector using his/her human relations skills, experience and knowledge of the intent of the application.

The inspector may not allow deviations from the specification. However, if he/she finds that any part of the agreed process is unworkable or impractical, he/she should request an amendment to the TPA with all parties involved. However, deviations from the requirements in the PSPC are not permitted.

Coating inspection is the foundation of the coating quality control for achieving the target useful coating life. Documentation entered into the CTF as required by the IMO PSPC shall reflect enforcement of the agreed specification as well as the requirements of the PSPC.

All the following only apply to steel within the areas covered by the IMO PSPC.

PRIMARY SURFACE PREPARATION

It is commonly stated that a high percentage (~70%) of all premature coating failures is the result from the improper surface preparation. The primary surface preparation is vital and considered as the foundation of all sequential top coatings. The definition of premature failure is *a coating that did not meet the expected service life in an acceptable coating condition*. The PSPC goal is to achieve a target useful coating life of 15 years in GOOD coating condition.

Ships consist of steel plates and beams (stiffeners welded from steel plates or profiled beams) constructed longitudinally and transversally. See Figures 5-12 and 14 for blocks constructed in a shipyard. The primary surface preparation and coating for the steel plates and profiled beams are normally completed in the automatic shop primer plant. Figure 2 shows a typical layout of steel plates and profiled beams on wheel abrator's roller conveyor.

Initial steel surface grades for steels stored in shipyards are usually A or B; that is, new steel with heavy mill-scale and normally light rust (see Figure 3). As a good practice, conditions C and especially D are not recommended for new constructions because of extensive pitting. Surface pre-cleaning and abrasive material selection/management are essential to have surface cleanliness Sa 2 ½ and surface profile roughness 30-75 µm for the PSPC requirement. Figure 4 shows typical blast materials (shots) and resultant steel surface after blasting.

Wise selection and management of abrasive blast material based on initial steel surface grade can provide efficient surface cleaning and high productivity. Shot is effective at breaking mill-scale, but much less so at removing rust. Grit is much better at removing rust than removing mill-scale. Hence, the highly productive plants typically use a mixture of shot and grit based on the steel surface grade. However, grit causes more equipment wear than shot. When the steel plates have a large amount of mill-scale, they will require a higher percentage of shot. The further away the abrator's wheel is configured from the plate, the greater amount of grit and shot is required. It is prudent to optimize the results through analyses and trials for the savings gained from reduced wear, the productivity and surface cleanliness quality. For this reason IMO left this issue to the paint manufacturers in order to clarify and advise upon their decisions. This is to be settled and agreed to in the TPA.

In the automatic shop primer plant, a wheel abrasor's centrifugal blast is normally configured for flat steel plates, not for different rolled profiles. The consequence is that blasting to profiled beams from the wheel abrator does not give a uniform surface cleanliness quality on all treated surfaces. This leaves non-conformity for those treated beams, which then should be identified by the qualified coating inspector for correction during the sequential construction stage (secondary surface preparation stage). The TPA should address this typical issue. As pointed out by Terry Greenfield's paper published in CoatingPro (page 54) in July 2009, some common pitfalls exist for the automatic shop primer machine, in which not all areas of both sides are treated uniformly. To overcome those pitfalls, periodic quality control inspection of the automatic shop primer plant is required and the coating inspector shall be alert to any non-conformity with surface cleanliness (oil/grease, soluble salts, dust, rust, mill scale, etc.) and roughness profile requirement for entire areas of both sides. Figure 4 shows access provided for examining the reverse side of steel plate. Regarding this issue, IACS PR 34 and UI 223 provide interpretation of automatic shop primer plant quality control requirements. It is the coating inspector's responsibility to confirm that the quality control procedures are providing compliance with PSPC. The quality control (QC) procedures include procedures for management of the blast material (including measurement of salts and contamination), procedures for measuring steel surface temperature, relative humidity and dew point, procedures for controlling or monitoring surface cleanliness (soluble salts, oil / grease / dust / other contaminants) and procedures for verifying thickness and curing of the shop primer. All such measurements and verifications according to the QC control process are to be documented in the CTF.

(a) Steel plate on roller conveyor (b) Profiled beams on roller conveyor

Figure 3 Typical Steel plate and profiled beams in wheel abrator

(a) Shots normally used for new steels (b) After blasted, Sa 2 ½ with 30 – 75 µm profile roughness is required

Figure 4 Blasting material, surface cleanliness and roughness after blasting

Shop primer (also known as preconstruction primer) is applied for the purpose of providing temporary protection from corrosion and mechanical damages during the construction period. Before starting any work at any construction stage, the shipyard needs to decide during the TPA discussion what coating system is to be applied. Using a certified shop primer could reduce secondary surface treatment work in the block stage. If the shop primer was tested and type approved as a part of the selected coating system, intact shop primer can be retained and only treated by sweep blast or high pressure water washing, or equivalent method, before the main coating is applied on the block stage. However, unproved shop primer needs to be cleaned to Sa 2 if the shop primer is compliant with the IMO PSPC, or Sa 2 ½ if it is not PSPC-compliant. It is obvious that the shipyard could gain savings by selecting the right shop primer before the PSPC project starts

In case where steel plates have been shop primed by the steel mills or by the contractor before being shipped to the shipyard, all above inspection requirements and records are required for verification, which will be a part of the information for the CTF.

STEEL WORKS

The IMO PSPC highlights that the coating performance can be improved by the ship design, such as by reducing scallops, using rolled profiles, avoiding complex geometric configurations and providing easy access for surface preparation, coating application and inspection. Depending on the ship structure design, T-shaped stiffeners or profiled stiffeners may be used. T-shaped stiffeners are usually cut and welded from steel plates, which have two (2) long welds between the flange and web plate and also have four (4) long sharp edges on the flanges. However, rolled profiles have no such welds and sharp edges. Figure 5 (a) shows the flanges and web plates for T-shapes stiffeners and Figure 5 (b) shows profile beams. All sharp edges from cutting, such as free edges on flanges, scallops, draining / air / key / lightening holes, etc., need to be treated to a minimum 2 mm rounded radius (see Figure 6(b)) by grinding or an equivalent process.

Sharp edges from small holes, scallops and others with irregular shapes are to be treated by manual grinding (see Figure 6(a)) only. In some shipyards, a machine, shown in Figure 7(b), is used to treat four (4) parallel long sharp edges on stiffener plates. Such a machine could speed up rounding of the sharp edges on stiffener plates, although manual pre-treatment (Figure 7(a)) is still needed before feeding them into the machine.

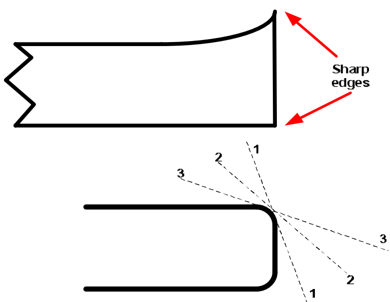
After steel plates and structural members are cut and welded into a block (Figure 8), all welds, defects and contamination from welding are to be treated as per requirements from ISO 8501-2 P2. It is highly recommended to validate the structure for requirements from necessary non-destructive tests and repairs if needed on this steel work stage before moving to the block blasting cell.

(a) Flange and web plates cut from steel plates for T-shape stiffeners

(b) Profiled stiffeners

Figure 5 Stiffeners used for ship structure

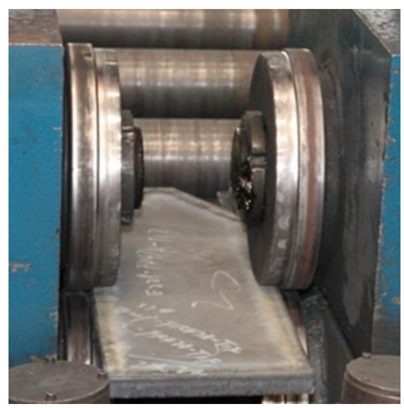
(a) Sharp edge grinding of all holes



(b) Minimum 2 mm round radius by 3-pass grinding or equivalent method

Figure 6 Sharp edge grinding of all holes and scallops

(a) Manual grinding (pre-treatment) for edges before sending to the edge rounding machine



(b) Edge rounding machine

Figure 7 Sharp edge rounding of straight edges

SECONDARY SURFACE PREPARATION AND COATING APPLICATION

After the blocks are completed (Figure 8) and the structural engineers/inspectors have validated the structure, the steel surface inspection is carried out to validate conformance to the standard required by the IMO PSPC. Only when the steel work of the block is completed should it be transported to the block blasting cell. The blocks should be as complete as possible before entering the blasting cell, meaning they should have installed ballast pipes, tunnels and Permanent Means of Access (PMA) such as rails, ladders, independent platforms, other equipment, etc. before blasting takes place. See Figure 9 for examples of supports for ladders and pipes. Those non-integral items are recommended to comply with the IMO PSPC to the extent possible so as not to impair the coating performance of the surrounding structure.

Figure 8 Shop primer damages from corrosion, welding, and mechanical at block stage

The type or degree of the secondary surface treatment depends on the pre-qualification of the coating system used and damaged surface condition during construction. The shop primer should be compliant with the IMO PSPC. The damaged shop primer (such as mechanical damages, corrosion and burns), new welds and edges, are to be grit-blasted to Sa 2 ½. The intact shop primer, pre-qualified as a part of the coating system, may remain and only be cleaned by high pressure water washing or sweep-blasting or an equivalent method in order provide a good adhesion to epoxy coating, so that no white rust and other contaminants exist on the surface. However, any intact shop primer which has not passed the pre-qualification is to be grit-blasted to Sa 2 (at least 70% removal on all areas). It shall be noted that any contamination left o the intact shop primer can cause a weak boundary between steel substrate and top coatings and will negatively affect the coating performance.

Figure 9 Non integral items installed before tank blasting and coating

In spite of this requirement for shop primer treatment set out by the IMO PSPC, many shipyards provide a complete grit-blasting to Sa 2 ½ for the whole block (see Figure 10(a)). This gives two advantages. One is that since there is no mill-scale left on the steel surfaces, grit-blasting is used during the block stage blasting. This is different from the shot-blasting commonly used for the primary surface preparation. The surface roughness profile from grit-blasting will provide better bonding than the peened surface generated by shot-blasting. The second advantage is the surface is completely treated to Sa 2 ½ again uniformly, and some surface defects left during the primary surface preparation can be corrected during the second surface blasting.

The high pressure water jetting is permitted by the IMO PSPC as one of the surface preparation methods when the shop primer is to be retained. This permission is not defined in detail. The stand-off distance, quality of the water (conductivity), pressure, out-put volume, post cleaning, drying, etc., is to be agreed upon and included in the TPA.

Some surface defects appear after blasting (Figure 10(b)). The IMO PSPC in general does not allow grinding (see Figure 10(c)) during the block stage after the block is blasted since grinding can damage the required surface roughness (see Figure 10(d)). However, minor corrections of defects by using a "high texture" disc, rather than to smooth the surface, should be considered. This should be discussed, included and agreed upon in the TPA. Considering that the GOOD coating condition is defined as < 3% coating breakdown on areas or < 20% on welds and edges, paint applied over ground areas in general is not expected to last 15 years of the target useful coating life. This total amount of grinding, including grinding applied to erection joints, coating repairs and welds, should not exceed the "allowable amount" of the total tank area (< 3%).

It is necessary to consider the entire process. For example, by selecting appropriate block divisions and using masking tape to minimize the erection joint area for the erection joint welding, allowance for other grinding repairs can be increased. The principal idea is to find the most beneficial path to meet the requirements of the IMO PSPC. Figure 11(a) shows the masking tape used to minimize erection joint area. Figure 11(b) shows the reduced erection joint area after coating, compared with Figure 11(d) in which no masking tape was used. Figure 11(c) illustrates that welds are protected from coating in preparation for water-tightness test. Those masked areas are allowed by IMO PSPC as a minimum to be treated by power tooling.

(a) Whole block blasted to Sa 2 ½ (b) Damages revealed after blasting

(c) Grinding after blasting is generally not permissible (d) Polished area by grinding

Figure 10 Blasting and grinding at the block stage

After the coating inspector has verified that the entire area to be coated meets the cleanliness, surface roughness and other requirements, such as the soluble salts and dust limitations, oil / grease/ or other possible contaminants, the air / steel temperatures, relative humidity, ventilation, etc., the coating is to be applied as soon as practicable.

Striping carried out before or after the first spray coat is allowed by the PSPC. However, striping before the first spray coat is always preferred, although it is recognized that, in some instances, it may not be practical, or even possible. IMO therefore did not mandate pre-striping before the first spray coat, and left this to be agreed upon at the TPA stage. Striping of welds and edges is to be done by using brushes; rollers can only be used for scallops and small holes (draining / air / lightening / key holes); see Figure 12 for typical stripe coating used. Touch-up of thickness behind stiffeners, bulb bars, etc., is not covered by the PSPC, and can be done by brush, roller or spray.

A minimum of two spray coats is to be applied. The thickness of each layer is not defined. Hence, for example, the first coat can in fact be a fast dry thin film wet-out primer (say 20 µm Dry Film Thickness (DFT)), and the second coat can be applied in 300 µm DFT. This still meets the IMO PSPC requirements for minimum 320 µm Nominal Dry Film Thickness (NDFT). It could be argued that this might be the most beneficial coating system for the future. The most common specification today, however, is two coats of 160 µm DFT each.

(a) Using masking tape to minimize the erection joint area before coating

(b) The erection joint area is reduced dramatically after using masking tape.

(c) Welds protected from coating for water tightness test

(d) Erection joint area without using masking tape

Figure 11 Minimizing erection area

Figure 12 Stripe coating

Controlling the application environment can be difficult as it depends upon the shipyard's capability. For instance, some shipyards do not have an indoor block blasting cell. Timing between blasting and coating application, temperature control, relative humidity control, etc. are critical to meet the requirements of the IMO PSPC and coating technical datasheets. The coating inspector is responsible for working with the parties to develop and enforce a solution that meets the IMO PSPC requirement.

ERECTION

Before erection and complete blocks have been largely painted, some areas need to be protected such as the erection joints and welds for water-tightness tests. The size of the erection join-up area, as pointed out in the above section, should be minimized by using masking tape. As a recommendation stemming from industry discussion, the erection joint area should be defined by giving minimum sizes permitted through a unified interpretation as indicated in Figure 14(c). Discussed in the previous section, power tooling is generally not allowed after the block is blasted on the block stage, but is allowed at the erection stage for butt-welded erection joint areas and small coating damages.

This butt-welded erection area and welds for water-tightness test can be treated with power tooling; blasting is preferred where it is practicable. The erection stage is not fully defined and nor is the total allowed erection area. However, as a PSPC principle, the total amount of such grinding within the complete tank should be as little as possible, and not to exceed the 3% of the total tank, in order to keep coating in the GOOD condition requiring less maintenance and repairs during the 15 years.

Power tool grinding for damaged coatings is permissible only for total coating damages up to 2% (exclude the erection joint areas and unpainted welds for water-tightness test) of the area (total tank area for ballast tank or double-side skin void space or area under deck for crude oil tank). If the damage is greater than that, blasting is required. The coating damage is defined as any damage, which reaches steel substrate, from burns, corrosion or mechanical operation. Any contiguous coating damage less than 25 m^2, but not greater than the 2% limitation, can be treated by power tooling. Otherwise, blasting is required per the IMO PSPC requirement. Coating repairs using grinding should be avoided and the shipyard should make all efforts to have the blocks completed before the block is blasted and coated.

It is debatable, and needs further interpretation of the IMO PSPC for crude oil tanks, whether coating damage allowance for power tooling is up to 20% for the tank top area (shaded area in Figure 13). For the same reason as stated above, the coating on the tank top will not last for 15 years if up to 20% of the area is prepared with power tooling. Frequent inspections, maintenance and repairs are expected in such areas to keep the coating in GOOD condition for 15 years.

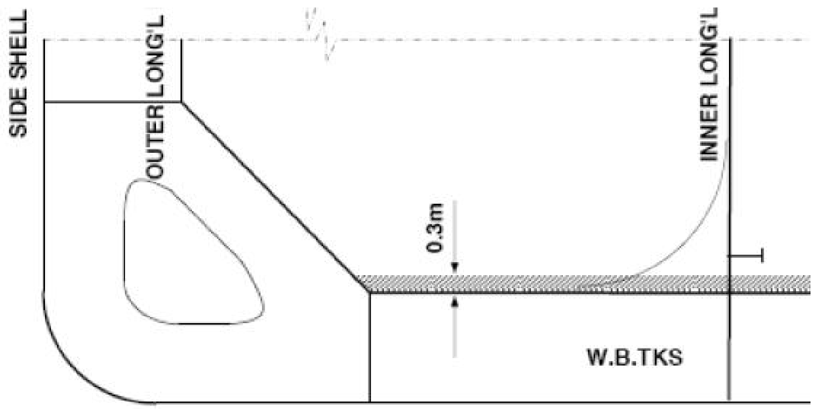
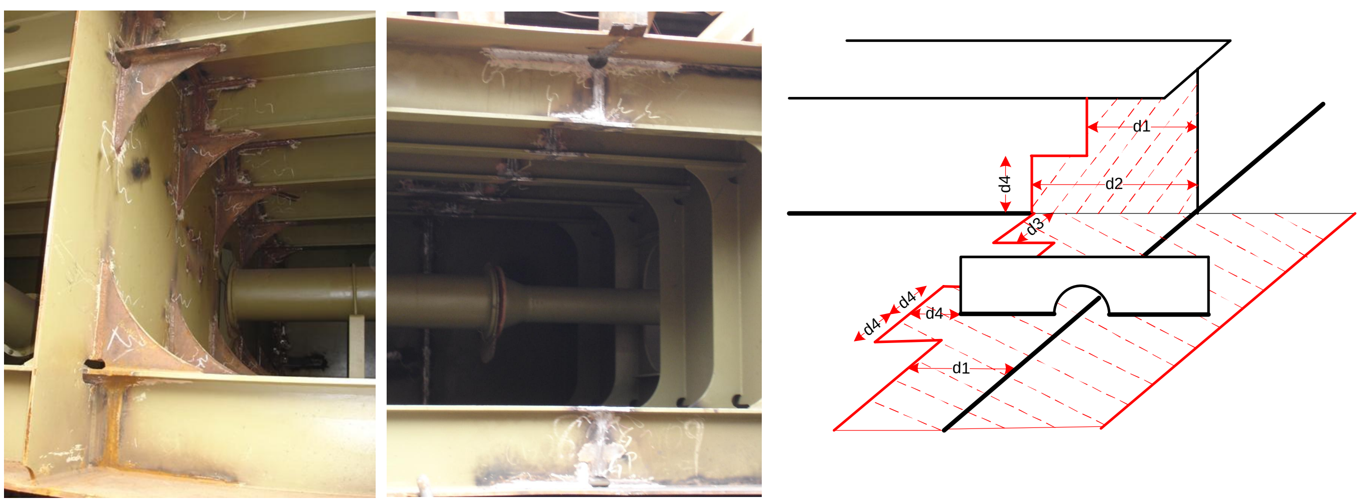


Figure 13 Tank top area (shaded) is to be coated to IMP PSPC

It is worth emphasizing again that the IMO PSPC does not define erection stage clearly and also does not define total erection area allowed. The number of blocks per tank and the block size could affect the total power tooled area within the tank. There is room left for the shipyard and ship owner to decide whether to incorporate this into the TPA. The principle is not to have a total power tooled area within the tank greater than 3% of the total tank area. The greater the total erection joint area and power tooling are, the more coating repairs are involved during ship operation. Figure 14(a) and (b) illustrate coating damages caused by erection. It shows that an appropriate block division can greatly reduce the power tooling after erection.



(a) (b) (c)

Figure 14 (a) and (b) illustrate block division effect on coating damages; (c) for erection area sizes – damages occurring outside of the shaded area contribute to the allowable 2%.

Coating repairs and coating application are to be in accordance with procedures in the TPA and the coating technical data sheets. As a common practice, coating feathering is required for coating in overlap. It is worth mentioning that the erection joint surface preparation and coating application are not usually done in a cell. In that case, steel / air temperatures, ventilation, relative humidity and contamination need to be monitored closely by the coating inspector for any non-conformity. Confined space safety requirements are also to be followed by all persons entering into such spaces.

FINAL COATING REPAIRS

When the tank is finished, there must be a final joint inspection by the shipyard QC, coating Inspector, and representatives from the ship owner and coating producer to check that all defective areas have been properly repaired, all outstanding statements have been cleared, and final DFT measurements have met 90/10 rules. All final DFT's are to be recorded and a summary inspection form for each completed tank needs to be signed and accepted by all parties.

ONBOARD IN-SERVICE MAINTENANCE AND REPAIR

Coating maintenance and repair is critical for the coating to remain in GOOD condition for the target of 15 years. According to IACS recommendation No.87, the coating is to be maintained in GOOD condition by minor touch-ups and on-board repairs when the coating condition is still in GOOD condition. All such maintenance events, normally done by vessel's crew, shall be reported in the CTF.

However, whenever the coating condition is lower than GOOD, the vessel needs to be scheduled for a repair to upgrade / restore coating rating to at least GOOD. This kind of repair is normally a major repair done in a shipyard. In this case, the CTF documentation is required, the same as the documentation provided at the new construction stage, such as coating system selection, coating inspector qualification and inspection, etc.

Class societies require a special survey every five (5) years with an intermediate survey in between when the coating is in GOOD condition or above. However, whenever the coating condition is below GOOD, an annual survey is required (see Table 1 below). This gives ship operators and ship owners an incentive for maintaining the coating in GOOD condition after the ship is delivered from the shipyard.

Table I Sample difference in frequency of inspections for ballast tanks

Coating Condition	Surveys (Internal Inspection)															
Good	S			I		S			I		S			I		S
Fair or Poor	S	A	A	I	A	S	A	A	I	A	S	A	A	I	A	S
Years	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Note S: Special Survey I: Intermediate Survey A: Annual Survey																

The IMO guideline for the maintenance and repair was developed by IMO (09/2010), and is in the review process. Before the new guideline is adopted by IMO, the maintenance and repair procedures are to be as per IACS Recommendation No. 87 and as recommended by the coating manufacturer. The maintenance and repair procedures shall also be agreed upon by the three parties during new construction and be available when the vessel is delivered.

COATING TECHNICAL FILE (CTF)

Many discussions have been taken place and much work has been done regarding the issue of how to manage and organize the CTF and how much information should be included in the CTF. The NACE task group, TG-402, is very active in developing a standard of the CTF requirement. Certain companies are also developing electronic products to help shipyards and ship operators manage and maintain the CTF. The CTF shall be kept on board and maintained throughout the life of the ship.

IMO PSPC requires that the CTF should be completed by the shipyard and reviewed by the flag State (usually a Class society acting as an RO) before the related certificate is issued. IMO PSPC sets out the minimum items to be included in the CTF (IMO PSPC 3.4) during new construction, in-service maintenance and repairs. There is still much room for interpretation on how much specific data is to be included in the CTF. Feedback from shipyards and ship owners is considered necessary to determine what data is needed onboard for the entire life of the vessel. The intent is to provide a safer ship for the officers and crew of a vessel, without the CFT becoming an unnecessary burden.

CONCLUSIONS

To reach the goal of 15 years useful coating life in GOOD condition from initial coating application, the initial work in time and care during new construction in the shipyard is a critical element. These initial efforts during the new construction in the shipyard include the clearly defined tripartite agreement on specification and inspection procedures, the selection of qualified and certified coating inspector(s), carrying out IMO PSPC-compliant primary surface preparation to meet cleanliness and roughness requirements, sharp edge grinding and weld treatment, blast cleaning for block stage surface preparation, coating repairs and power tooling at the erection stage and comprehensive CTF documentation. The standardization of shipyard new construction processes to meet the PSPC requirements not only has the potential for improving the quality of coating, but also provides an opportunity for better controlling costs during construction and throughout the service life of the vessel.