The implementation process analysis and improvement on PSPC in China shipyards

1. Zhoubin. <int9900@hot.com>
Shanghai Waigaoqiao Marine&Offshore Design Co.,Ltd, Shanghai, China
2. Li meilin. <limeilin660@163.com>
Shanghai Shipbuilding Technology Research Institute, Shanghai, China
3. Wangying. <wangyingjo@163.com>
Shanghai Waigaoqiao Marine&Offshore Design Co.,Ltd, Shanghai, China

Abstract

This paper introduces the PSPC implementation process in China shipyards, combined with the requirement of PSPC and factory practice, summarizes suits the implementation practices on PSPC ships, which provides technical foundation for the construction of PSPC ships.

1 Introduction

The Performance Standard of Protective Coating for ship water ballast tanks (PSPC) was adopted at MSC82 meeting on December 8, 2006, and was introduced to SOLAS chapter II-1 A-1 Section 3-2 requirement for enforcement. Since the implementation of PSPC for the ballast tanks, the shipbuilding industry has paid high attention to it. By closely with the relevant departments, the enterprises have developed a strict management system after a long meticulous planning, simulation and PSPC standard implementation of effective shipping, and implementation PSPC was smooth, shipyard can deal with the suggestions well by the owners and ship inspector in time, which ensure the successful delivery ships.

2 Analysis of PSPC Implementation Process

The paper took the main ship type of certain backbone shipyard as example. With the unremitting efforts, now the PSPC ships built by the shipyard, the surface roughness, salt, grease, dust, film thickness and the free edge processing etc. of block coating for the water ballast tanks can basically reach the PSPC standard requirements, but there are still greater difficulties in meeting the requirements of PSPC standard, which is, "Small damages up to 2% of total area:St 3. Contiguous damages over 25 m2 or over 2% of the total area of the tank, Sa 2½ shall be applied. ", as shown in Fig1 and Fig2. Therefore, how to control the coating damage rate for the water ballast tank less than 2% is a difficult problem for PSPC standards implementation, which has been the biggest and most difficult problem for the entire shipbuilding process.

2 Analysis of PSPC Implementation Process

Fig.1 H1053 coating damage condition (after erection of the entire tank)

Fig.2 H1053 coating damage condition (man-made damage)

2 Analysis of PSPC Implementation Process

Took No.9 ballast tanks of the PSPC effective ship H1112 manufactured by the shipyard firstly as example, the reasons of the excessive coating damage through the water ballast tanks after erection.

- The coating damage caused by the welding spatter scald.

  As workers have weaker protection awareness while welding and cutting, or the coating protection work is not in place, the welding slag will burn the surrounding coating, and formed large area of coating burn pitting.

- If the protective measures of hull erection are not in place, the burning coating width on both sides of the butt weld will be greater than 200mm, and the excess portion will be included in the coating damaged area.

2 Analysis of PSPC Implementation Process

- **Precision cutting.**

  The success rate of the block /grand block precision control is not high, and the weld joints re-welding sites in the erection process are more, especially the accuracy control of curve surface block with larger line type, such as the forepeak, the stern, ring 1, ring 9, is difficult, which will lead to the bigger damage area while accuracy cutting;

- **Attachments and bulk parts.**

  During the block manufacture, as the workers don't attach in line with drawings or the design affixing position and ways are unreasonable, a large-scale coating damage will be produced while bulk pasting. Therefore, optimization design by reducing attachments should be one of the directions advanced production design;

2 Analysis of PSPC Implementation Process

- Fire work. If the welding deformation is controlled badly, it usually needs a large area of the fire work shaping after erection, and the coating damage is severe;
- Lug cutting. When the workers use the flame to cut the lugs, it will easily result in the coating damage of the steel inverse. Expanding the lug uncut area and the use of the promotion of the lug polished machines can reduce the coating damage area on lug cutting;
- Mechanical damage and man-made destruction. For some reasons, such as the low PSPC awareness of the workers, poor coating protective awareness during the construction process, building and removing the scaffold, random arc-making, the brutal application and poor "5S" clean, the man-made coating damage is created;

2 Analysis of PSPC Implementation Process

In addition, design is also one of the main factors affecting the coating damage.

For example, the pre-designed block division is not reasonable, which is likely to cause the inevitable welding destruction after erection; the drawing pre-outfitting rate is not high during block making stage of the production design, while there are too many bulk pieces (paste accessories), whose placement is inappropriate; specialty coordination is still not sufficient, and design modification is too much.

3 Technical Management Measures

1) Making standard tripartite agreement

In order to unfold PSPC work better, before the enactment of the PSPC tripartite agreement, based on the PSPC standard implementation experience of the simulation ship, we discussed and revised tripartite agreement contents with the owners, paint manufacturers many times in line with PSPC specification, and finally developed the better standard tripartite agreement template.

3 Technical Management Measures

2) Establish the implementation process control system of the PSPC standard

On the basis of analyzing the impact on the PSPC standard implementation in the main shipbuilding process, combined with the PSPC standard requirements, we decomposed the PSPC implementation difficulty to the main shipbuilding process, confirm the control points of the various aspects, and take the relevant control method at each control point, so as to ensure that the PSPC standard implementation is monitored throughout the whole process (PSPC standard implementation control points are as shown in Fig 3).

3 Technical Management Measures

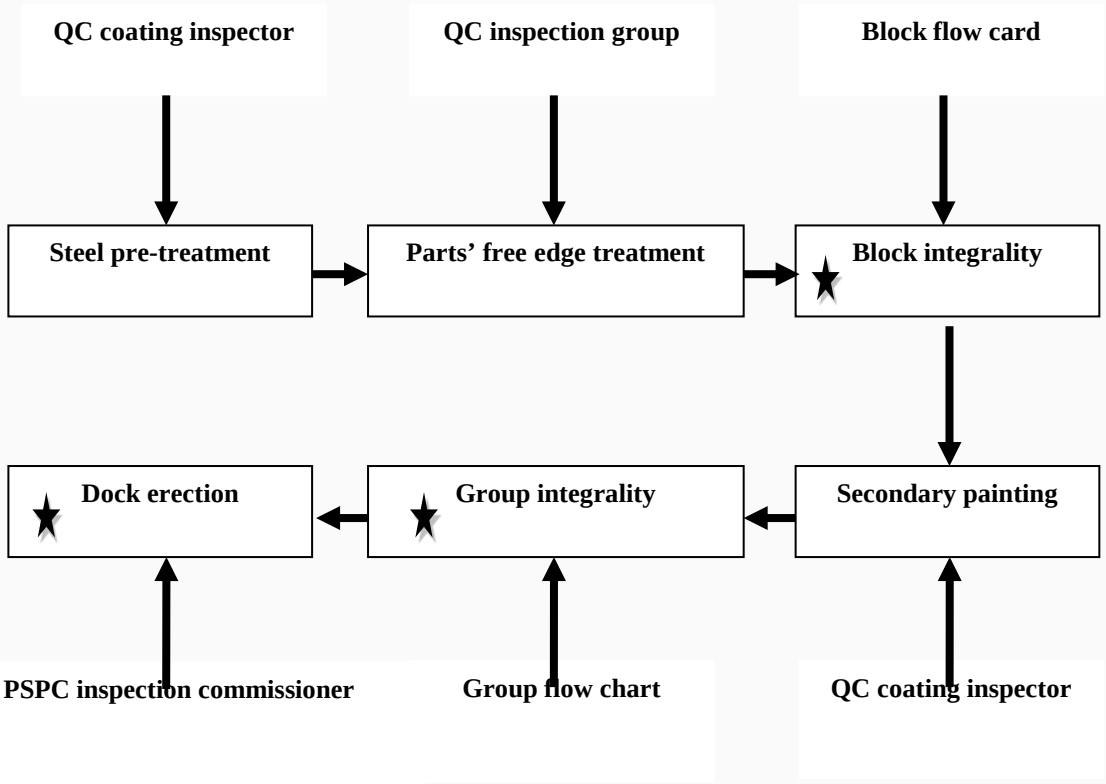

Fig.3 PSPC standard implementation control point chart

（ ★stand for key control points ）

3 Technical Management Measures

3) Continuous training

Based on the different requirements of implementing the PSPC standards by productive sectors, we aimed to prepare “PSPC Publication Manual” for production department, and issued to the on-site workers and management personnel, basically achieved the full coverage of the PSPC propagandize. At the same time, we organized people to visit the advanced domestic shipyards for communication and learning, and carried out the qualified coating inspector training work.

4 Process Improvement

Based on the research and analysis of PSPC standards implementation on the new shipbuilding, As it is difficult to control the PSPC standard coating damage, we mainly took the following measures through continuous exploration and practice:

1) Deepen the production design and improve the block integrity

A. Block-divide reasonably to reduce the coating damage for the ballast tank

On the basis of meeting company's equipment production capacity and structural strength, the hull structure design and block division should try to meet the PSPC requirements. The reasonable block division should keep to the following principles in order to reduce the coating damage of the ballast tank.

4 Process Improvement

- Expand the grand block construction mode, make the coating after the block grouping of the ballast tank region, and reduce coating damage from the group weld seam ;
- Block division should seek the integrity of the outfitting installation, and avoid the large outfitting installation of the cross block, such as bollards, fairleads, horizontal wheel and breath windpipe etc.;
- The location of the block weld lines should create favorable conditions for the coating, try to ensure the integrity of the ballast tank coating, divide the ballast tanks into the independent segments, and reduce the coating damage of the weld line on the ballast tank compartments.

4 Process Improvement

B. Embody structure treatment requirements for water the ballast tanks in the cutting edition drawing.

According to the PSPC standards, the edge of the ballast tank should be treated to the circular angle and radius at least 2mm, or have three-time grinding or at least the equivalent processing. But for the processing department, the construction workers can generally not know that the machined parts belong to which area, so the grinding parts will be missed or the polished processing scope will be expanded, which will waste the unnecessary working hours.

4 Process Improvement

C. expand the outfitting forward and reduce the coating damage for water ballast tank

Increase the pre-outfitting rate, that is, advance the outfitting installation at the block and regional stage. In this way, it can not only shorten the outfitting time at dock and quay wharf stage, but also greatly reduce the damage area of the ballast tank coating. In the outfitting design of H1112, by optimizing the design, the outfitting pieces inside and outside the ballast tanks use the outfitting plate pre-firing process. Currently, in order to avoid outfitting pieces nearby to produce the greater impact on water ballast tank coating damage, the pre-outfitting rate of the bow and the stern nearby cargo area will reach 80%, while the cargo area can be achieved 95%.

4 Process Improvement

2) Improve the shipbuilding accuracy and lower the repair& cutting rate of the hull structure

A. optimize the block reinforcement and the support process

In the precision control of the block construction, it is found that some blocks' structure strengthening is inadequate, which is prone to the deformation while lifting, shelving or sanding, so the engineering chamber, assembly department and precision management department are organized to take the optimization work of the block strengthening and supporting process. At present, the modeling of 206K BC block strengthening has been completed. For example, in fig 4 "the model of the typical engine tank block strengthening", the slot steel supporting of the block section below can ensure the structural rigidity and reduce the deformation.

4 Process Improvement

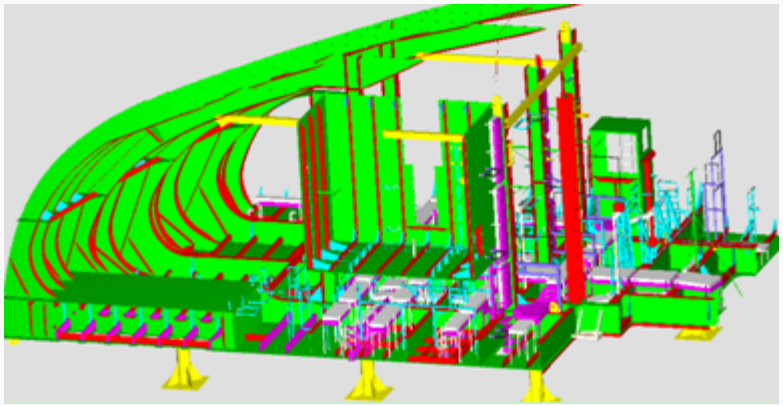

Fig4. The model of the typical engine tank block strengthening

4 Process Improvement

B. Advance the painting reservation technology for 100 MARK line

There are two main purposes for 100 MARK line coating remaining. One is improving the fabricating accuracy of 10-byte head component in the assembly operation and reducing the stress concentration; the other is reducing the coating damage on the welding joints area between blocks while back group or erection works. The production design did 100 MARK line coating remaining drawings. It is required that the assembly department must knock out the sample spots with punch in the block construction, and put them into the block accuracy assessment. The painting department should paste the adhesive tape in accordance with the drawings, and avoid the paint burn phenomenon of the back road in the angle welding area between the blocks. In this way, it will effectively reduce the following labor amount and the coating damage, which will lay a good foundation for the implementation of the new PSPC specification.

4 Process Improvement

C. Promote the back burn technology of block big joints

The purpose of block back bum is to eliminate the residual stress generated by welding, correct distortion, and prevent hull to be distortion. heating working for part welding opposite surface aims to reduce paint damage at block group and erection stage. All the back heating should be done on the back of the welding with the flame after finishing small, medium and large assembly work, and the optimum heating temperature is 600 to 700 degrees. Its heating position is shown in Fig5. According to the orientation of the butt bevel, the effect after the back burning is shown in Fig6.

4 Process Improvement

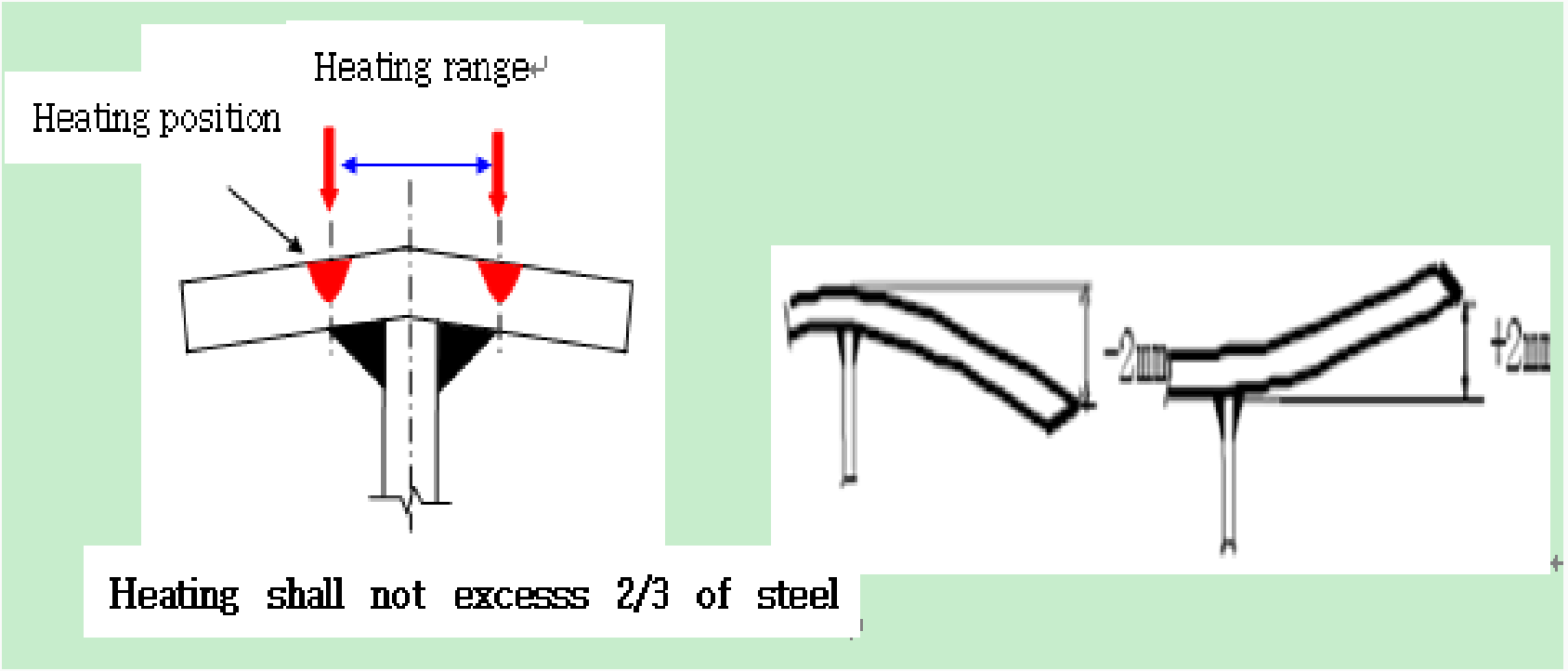

Fig5. back burn position drawing

Fig6. effect drawing after back burn

Presently, the back burn of block butts acts as a block D precision into the block accuracy assessment. By viewing the on-site implementation situation, the fire work at group and erection stage has been significantly reduced.

4 Process Improvement

3) Strengthen coating protection work for water ballast tank

A. Enhance the publicizing education of coating protection for water ballast tank

- Before the welding, repair cut and carbon dig jobs, the fireproof cloth, white sheet iron should be laid in the application influence area, so as to avoid the welding slag and the spark to burn the paint around;
- All the ship in the implementation of PSPC standards and the blocks relate to water ballast tanks, in the process of group and erection, if they need the structure cutting, board change and fire work operation, it is required to submit an application for fire work, and start to work after the approval;

- While welding, prohibit to make arc in water ballast tank coating freely, and it should be made arc and ignite in the range of block seams less than 200mm;
- While handling the objects (out fittings, tooling pieces, scaffold materials), it should prevent the collision with the hull and the mechanical damage;
- In order to avoid the paint coating damage for water ballast tanks, while erecting the scaffolds, the rubber gasket should be used in the contact of the scaffold and the water ballast tank coating.

4 Process Improvement

- After finishing daily job, workers should clean the garbage in time, such as scrap iron, sewage, waste materials etc within their own operation areas, so as to avoid the hull corrosion after the coating damage resulted from the garbage accumulation for a long time;
- In order to prevent the rainwater from entering water ballast tanks, while going to the dock, the area of the internal board etc. should be installed the waterproof door ring ;
- According to “the ballast tank application passage layout drawing”, lay the relevant protective materials such as the three-anti cloth and aluminum foil adhesive tape, to reduce the passage paint damage.

4 Process Improvement

B. Strengthen the on-site monitoring

In order to ensure that the workers can protect water ballast tank coating as required at dock stage, two PSPC ballast tanks inspectors in each PSPC vessel, whose duty is to do the supervision and inspection according to the daily checklist for the ballast tanks (see Table 1), and monitor the on-site construction personnel to implement the protection work of paint film by the requirements.

4 Process Improvement

Table 1 the daily checklist for ballast tanks

H1112 PSPC daily check point

area	No	Inspection items	Inspection result		
Cargo Tank inner bottom plate area	1	warning brand in bow	□normal	□abnormal, Improvement after informed	□ abnormal, Improvement at scene
	2	warning brand in aft	□normal	□abnormal, Improvement after informed	□ abnormal, Improvement at scene
	3	warning brand of the craft hole	□normal	□abnormal, Improvement after informed	□ abnormal, Improvement at scene
	4	welding machine ground in inner bottom plate	□normal, no new damage		□abnormal, New damage
	5	The unexpected broken by hot work	□not much		□much, must clean
	6	seeper	□not much		□much, must clean
Double bottom operation passage area	1	Laying the protection material of worker passageway floor	□normal	□ abnormal, Improvement at scene	□abnormal, Improvement after informed, annex photoes
	2	The protection of man-hole in floor plate	□normal	□ abnormal, Improvement at scene	□abnormal, Improvement after informed, annex photoes
	3	Seeper and waste in worker passageway	□normal	□ abnormal, Improvement at scene	□abnormal, Improvement after informed,

4 Process Improvement

					annex photoes
	4	floor plate assembly	□normal	□ abnormal, Improvement at scene	□abnormal, Improvement after informed, annex photoes
	5	The tools placed circumstances in worker passageway	□ normal, according to the requirer		□ abnormal, Not according to the requirer, annex photoes
	6	Ladder and assembly pretection in worker passageway	□ normal, no assembly or assembly pretected		□normal, assembly not pretected
	7	The coating damage in ballast tank	□normal, no new damage		□abnormal, New damage, annex photoes
Wing tank area	1	Laying the protection material of floor	□normal	□ abnormal, Improvement at scene	□abnormal, Improvement after informed, annex photoes
	2	Seeper and waste	□normal	□ abnormal, Improvement at scene	□abnormal, Improvement after informed, annex photoes
	3	The protection of false work	□normal, no assembly or assembly pretected		□normal, assembly not pretected
	4	The unexpected coating damage in ballast tank	□normal, no new damage		□abnormal, New damage, annex photoes

4 Process Improvement

C. Strengthen the paint film protection assessment of water ballast tanks

In order to strengthen coating protective work of water ballast tanks, based on the fixed PSPC monthly performance assessment framework in each department, increase the assessment of the monthly PSPC paint protection for water ballast tanks. As separate monthly assessment indicators, the responsibilities implement to individual in line with “Incentives and Disincentives ways of PSPC Paint Protection for Ballast Tank” issued by the Ministry department.

4 Process Improvement

4) Optimize the scaffold erection and reduce the coating damage for water ballast tank

To avoid scaffold and hull direct contact to damage water ballast tank coatings, the scaffold design amended the original welding erection form, and promote the use of fabricated scaffold in water ballast tanks greatly. In the area of the ballast tanks erection seams and watertight board lay the scaffold pieces, and use the fabricated scaffolds, while the scaffold pieces will be remained in the hull as a permanent piece. In the fabricated scaffolding erection process, the protection measurements on the scaffold pieces are increased that all the contact areas with the scaffold pieces use the rubber pad for protection, which effectively ensures the integrity of the coating, as shown in Fig7.

4 Process Improvement

Fig.7 Erection effect drawing of water ballast tanks fabricated scaffold

4 Process Improvement

5) Adopt the new painting technology and equipments

A. For the steel plate pretreatment, using the new type abrasive-low mixed abrasive, which could greatly improve the passing rate of the steel surface pretreatment indicators. Meanwhile, the using abrasive amount can be saved by 50%.

B. For the pieces free edge grinding, using a variety of devices (such as manual chamfering machine, the T-row chamfering machine, the rib automatic chamfering machine) can improve grinding efficiency.

4 Process Improvement

C. When the coating damage is excessive, use the sponge abrasive low dust blasting process as the emergency treatment plan. In this way, it is efficient to get rid of the rust and clean more easily, which will solve the problem of extending the dock schedule, and improve the response capacity of the PSPC standard as well.

D. To reduce the damage of the flames construction on the paint of the ballast tanks, use the lug polished machine, and modified the lug cut from the flame cutting to the machine processing way, which will greatly improve the efficiency of lug and code board cutting.

5 Conclusion

Based on response to the implementation of PSPC, the hardware facilities, construction process, construction technology and management level etc. of the domestic shipbuilding enterprises have generally increased. In particular, through the process reengineering, the relevant PSPC process from backbone shipbuilding enterprises have fully involved in total assembly of the shipbuilding process , which has successfully delivered a large batch of the ships to meet the PSPC requirements.

Thanks