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Update on NSRP-US Navy Initiatives to Reduce the Costs of Painting Navy Ships

ABSTRACT

The paper discusses how the US Navy and NSRP Surface Preparation & Coatings Panel are working together to reduce the cost of painting Navy ships. In addition to describing the various entities and how they interact, the paper summarizes several recent initiatives such as the determination of environmental recorder requirements, cost-benefit analysis of salt mitigation, retention of pre-construction primers, humidity control during tank painting, acceptability of flash rust on hydroblasted surfaces, and implementation of single coat tank coatings.

INTRODUCTION

NSRP Surface Preparation & Coatings Panel

The National Shipbuilding Research Program’s Surface Preparation & Coatings Panel is an active group of representatives from the shipbuilding and coatings industries who work together to improve surface preparation and coating processes during shipbuilding.

The Surface Preparation & Coatings Panel was one of the original NSRP technical panels. Through its long history, the panel has provided a public forum for discussing specifications, receipt inspection of materials, preparation for coating, application of coatings, personnel protection, and clean-up and environmental compliance, as they relate to the shipbuilding/repair industry and its customers.

NSRP originally was originally sponsored by the Maritime Administration (MarAd). The Maritime Administration’s focus was to assist American shipyards be more competitive in the world marketplace building commercial ships. The first meeting was in Atlanta in 1973 and was organized as a shipbuilding industrial engineering workshop. Following this meeting, SNAME acted as the facilitator and a SNAME Panel, O23-1 was established to address surface preparation and coatings issues. As the US commercial shipbuilding market dropped off, the US Navy became the NSRP program sponsor. Around 1986, the panel assumed the name SP-3, Surface Preparation and Coatings, and then when NSRP was restructured in 1999 it became simply the Surface Preparation & Coatings Panel—SPC Panel for short.

Panel meeting discussions regularly reveal project opportunities that are important to the shipbuilding industry. The NSRP Executive Control Board (ECB) typically sets aside a modest amount of money each year to fund relatively small (less than $100K), short-term (12 months or less) projects recommended by the Panel Chairs. Once a solicitation is issued, Panel proposals are submitted to the Panel Chairs in the form of short white papers; the Panels then vote on which papers (up to three) to submit for consideration by the ECB. Submissions from all the Panels are then put through a competitive selection process in which the ECB selects a Panel Project portfolio for that year.

US Navy Paint Process Improvement

During the January 26, 2006 Joint Fleet/NAVSEA JINII committee meeting, RADM Hugel indicated that the fair market value of preservation painting for FY06-08 is $250M, the actual cost of which will be $420M unless improvements are realized – a potential cost savings of 40%. Several initiatives have been undertaken to reduce overall painting costs, including development of standard procedures, expansion of training programs, and the
strengthening of systems to facilitate information flow.

Surface preparation and coating on US Navy ships is performed by a variety of activities including Navy shipyards, private shipyards, industrial painting contractors and ships force. The rules governing the various activities have historically varied. Current Navy strategy is to move all of the various activities to a common governing document for surface preparation and coating activities (Navy Standard Item 009-32). This provides an opportunity to consolidate best practices from across the industrial base to reduce costs without impacting performance.

Figure 1 schematically shows how two key groups (Public and Private shipyards) engage in improvement of Navy surface preparation and coating requirements. Change concepts may come from a variety of sources but ultimately end up in either a public or private shipyard for proof of concept.

Either the public or private shipyard will perform the necessary data collection, solution development and process demonstration required to validate and a process improvement. NSRP is one source of funding for demonstration in private shipyards while Cumbersome Work Practices (CWP) is a source of funding for projects performed by the Naval Shipyards (Public Yards).

Public and Private Shipyards have different operating constraints and business practices. Once the necessary data has been collected and initial demonstrations performed, the information is typically fed to the other type of shipyard for validation. Based on the collaborative work, a formalized change concept is provided to the Navy Technical Warrant Holder for approval and institutionalized in changes to the governing technical document.

NSRP SURFACE PREPARATION & COATINGS PANEL TECHNICAL INITIATIVES

Over the years, the SPC Panel has sponsored a number of projects which have resulted in over 100 published technical reports. The projects have included process improvement studies, surveys of shipyard practices, demonstration of new technologies, and adaptation of technologies from other industries. Following are six of the initiatives which NSRP is actively working on or has recently completed.

Determine Environmental Recorder Requirements

Paragraph 3.10.1.6 of the current (FY11) NSI 009-32 states “The preferred method of measurement is using a data logger (Veriteq Instruments, Inc., Model No. KT-2000-NEI or equivalent).” The definition of “or equivalent” has been subject to interpretation. One particular issue that remains unclear is the need for explosion proof or intrinsically safe certification. The NSRP panel has been working with member shipyards and the Navy to develop improved wording for this paragraph. In support of this effort, the panel has sponsored a project to look at the broader issue of alternative Coatings System Environmental Recorder (i.e. Data Logger) in support of the Specification for Environment and Surface Contact Temperature Record System.

The broader project will look at the latest technologies not only for their compliance with the NSI 009-32 requirements but also at the
ability to reduce human intervention (thus increasing efficiency and reducing cost) and increase the Shipyard’s ability to share environmental data internally and externally (e.g., with various regularity agencies and its customers). The project will culminate with a final report to NSRP Surface Preparation & Coatings Panel and the US Navy. That report will include a statement of the relative equivalency of the various commercially available environmental monitoring equipment and/or systems with data logging capabilities.

**Cost-Benefit Analysis of Salt Mitigation**

Literature in the late 1980’s and early 1990’s all began to point to underfilm soluble salts as a major contributor to subsequent coating deterioration. Salts just above the Lower Detection Limit (LDL) of commercially available detection technologies were shown, over-time, to accelerate the blistering and rust-through of coatings under immersion conditions. Based on these findings, about 3 μg/cm² NaCl became the U.S. Navy acceptable limit for immersion service. (Ellor and Farschon, 1997) The IMO PSPC has an acceptable limit of about 5 μg/cm² NaCl.

When excessive salt levels are identified, they are commonly remediated with a water wash. Remediation results in surface rusting what must be subsequently abrasive blasted. There is concern by some in the shipbuilding community that the costs of mitigating high salt levels may outweigh the benefits in some instances. The project will rely heavily of production data from participating shipyards to determine the cost versus benefits and evaluate risk assessment for various levels and/or distribution of soluble salts. Secondary project goals are to expand our understanding of the reproducibility of soluble salt measurements in the field and to determine optimum preservation process instructions for salt remediation to reduce variance requests, decrease mitigation costs, and delay time.

**Retention of Pre-Construction Primer**

Current Navy practice requires the removal of pre-construction primers (PCP) by blasting prior to application of the final coating system. PCP is a zinc-containing, weld-through primer applied at low thickness to minimize rusting of steel during storage and fabrication. PCP removal is perceived to reduce risk of coating failure associated with painting over an aged zinc primer. PCP is retained in most commercial shipbuilding operations in order to reduce costs and provide a better performing coating system.

An NSRP project reviewed existing Navy shipbuilding processes and commercial practices and develop a procedure for retention of PCP in which the NAVSEA Technical Warrant Holder will have confidence. Three critical issues were explored by the project:

- What are PCP application requirements? How do we make them consistent with existing Navy requirements?
- What secondary preparation of weathered PCP surfaces is required?
- How should we inspect prepared PCP prior to application of anticorrosive system?

Based on the results of the project, process changes for Navy painting practices were recommended for adoption in the FY12 version of NSI 009-32. The proposed changes to NSI 009-32 will allow pre-construction primer (PCP) to be retained on repaired steel up to some percentage of the surface area of critical coated surfaces except for potable water tanks, feedwater tanks, and freshwater drain collecting tanks.

Under the proposed change, the PCP would be a zinc silicate material which is compatible with the specified coating system. The PCP would be applied in a certified process which meets the technical requirements (i.e., acceptance criteria) of NSI 009-32. Retained PCP would have secondary surface preparation using either low pressure water cleaning in accordance with SSPC SP-12 or brush off blast cleaning in general accordance with SSPC SP-7. If water cleaning is used, mechanically damaged PCP would be prepared to a minimum SSPC SP-15.
Visual evidence of excessive film build or mud cracking would not be permitted. If cleaned using water, the degree of water break would be inspected as the water cleaning is being performed. If the surface is clean and free of oily residue, the water spray should sheet off.

**Relax the Requirement to maintain 50% Relative Humidity during Tank Painting**

A previous NSRP panel project identified the requirement to maintain the relative humidity in a tank or void space at a maximum of 50 percent from the start of surface preparation to cure of the topcoat as one of the most expensive requirements in Navy Standard Item 009-32. (NSRP, 2007b) Shipyards have requested that the Navy amend 009-32 to allow tank painting at manufacturers recommended conditions (commonly 85% relative humidity). The Navy has determined that the lower relative humidity reduces the risk of pre-mature coating failure and is warranted given the military-unique risk tolerance. Specifically, the Navy believes that achieving and maintaining 50% RH during coating application and curing will reduce performance, cost and schedule risks at a negligible cost. (NAVSEA, 2005)

The NSRP funded a project to explore both sides of the argument and develop a proposal for an intermediate solution – one which addresses the Navy concern regarding risk reduction without increasing costs as drastically as the 50% RH requirement. The project facilitated a series of working group meetings and information exchanges between representatives from the Navy, shipyards, and industry. Based on these meetings, the group came to a consensus that the following modifications should be considered for adoption by the Navy:

- Waive 50% for shop painted items (The short time between surface prep and paint poses lower risk while the large volume of most shops increase cost)
- Waive 50% for small CHT tanks (The short time between surface prep and paint poses lower risk while the distribution of mobilization costs over a small surface area increases cost)
- Only maintain conditions until “dry-to-touch” vs. “final cure” (Maintaining lower RH during the shorter time reduces the cost and logistics of maintaining low RH while the impact of higher humidity is significantly lower once the coating has dried)
- Allow 85% for touch up areas per 3.6.2.4 (The cost to maintain lower humidity is distributed across a smaller work area, thus the cost-benefit ratio is high)

The changes will have an immediate impact on the cost to paint Navy tanks where dehumidification is required due to the ambient relative humidity. These changes will take effect in the FY2011 version of NSI 009-32. In US shipyards, ambient relative humidity is below 50% about 10% of the time. However, if painting can occur when relative humidity is as high as 85%, most shipyards can paint 80% of the time without dehumidification equipment. Dehumidifying paint shops to meet the 50% requirement can require millions of dollars worth of equipment. Allowing surface preparation and painting at 85% relative humidity obviates the need for such equipment. In the drydock, dehumidification equipment results in cost and space constraints. The ability to move dehumidification equipment before touch up and full cure is completed means less equipment is needed for a series of tanks.

A Final Report is available on the NSRP website. The report includes an easy reference written for deckplate personnel which highlights the changes to the specification requirements.

**Acceptable Flash Rust Levels after Hydroblasting**

As regulatory constraints have increased the requirements for abrasive blasting, ultra high pressure water jetting (UHPWJ) has become an increasingly common method of surface preparation to remove hull coatings in preparation for painting. Unfortunately, surface preparation with water can result in rusting of the prepared steel surface. This phenomena, referred to as “flash rusting” has the potential to negatively impact coating performance if it
interferes with adhesion or serves as a catalyst for osmotic blistering. Experience has shown that some level of flash rusting is acceptable, however characterizing the nature of flash rust and agreeing on an acceptable level has been the subject of much debate in the industry.

Closed-loop, semi-automated equipment for UHPWJ surface preparation leaves a surface which is generally less susceptible to flash rusting. However, automated equipment cannot remove coatings adjacent to hull protrusions and penetrations (bilge keels, pad eyes, seachests, etc.). These areas are generally prepared with open loop, hand lances. Because of the higher time of wetness resulting from this process, higher levels of flash rust are more common. A secondary surface preparation step is often required to remove this flash rust. There are two key questions surrounding the issue of painting over flash rust:

- What levels of flash rust can be painted over?
- How do we quantify the level of flash rust?

The NSRP has undertaken three projects to address these issues. To better understand the impact of flash rusting on coating life, one project compared the performance of coatings applied to four (4) Navy hulls prepared with open/closed-loop UHPWJ systems on broad areas and hand lance UHPWJ with minimal secondary surface preparation in complex hull areas. (NSRP, 2007a) The data suggested that there was no difference in the two areas on four ships after exposure lives of five to six years. This lends support to the argument that there is no need for secondary surface preparation after preparing the surfaces with hand lance equipment. A follow-on study is currently underway to collect data from additional Navy ships.

A third project was performed to reduce uncertainty between inspectors and production personnel, and to reduce costs by the time that is spent in additional paperwork “approval” for a variance. In this project, a stand-alone training manual was developed to focus on the fundamentals of inspection for Flash Rust as found in WaterJet or Wet Abrasive Blast Cleaning when a surface is being prepared for painting. This Training Manual was designed as a supplement to inspection experience and certification courses. (NSRP, 2008a)

All of these efforts are being performed in conjunction with a Navy Cumbersome Work Practice 351 (CWP-351) initiative on the same topic. The Navy CWP effort uses the NSRP data in conjunction with their own work to evaluate the potential for increased performance risk and the opportunity for cost reduction. On the basis of this risk-reward analysis, the Navy will be able to make an informed business decision on the surface preparation requirement.

**Single Coat Tank Coatings**

A one-coat, rapid-cure preservation system has been identified by the Navy as a method to significantly reduce coatings costs and shorten the duration of painting activities. As part of a Navy CWP effort, a Preservation Process Instruction (PPI) for using the system was developed. All public yards have used this system and some of the private shipyards and their sub-contractors have conducted pilot “test & evaluate” contracts with this coating system.

The National Shipbuilding Research Program (NSRP) funded a project to assist the Navy in fast-tracking the use of single coat tank preservation process in the private shipyards by developing tools which will help them define the costs, benefits and risks associated with transitioning to single coat from traditional tank coatings. (NSRP, 2008b) There are upfront costs associated with the implementation of this technology including equipment upgrades, training, certifications and lessons learned. A private contractor must be able to measure the risk vs. reward involved in a new process.

This NSRP project resulted in two primary deliverables to facilitate the transition to single coat preservation systems:

- A written guide containing “lessons learned” and reference material which will be useful
for any shipyard considering adopting the technology

- A spreadsheet allowing comparison of initial and recurring costs associated with the single coat and legacy preservation systems to help a shipyard identify costs and risks associated with implementing single coat as well as help the user estimate the potential reduction in schedule days from their existing process to a fully operational single coat process.

In addition to formal deliverables, the project engaged the private shipyard community in meetings, teleconferences and other communications to discuss the single coat process. This has helped to expedite private shipyard acceptance of the single coat preservation system.

CONCLUSION

The NSRP Surface Preparation & Coatings Panel provides a forum for private US shipyards to work with the US Navy to reduce the overall costs of ship painting. The panel facilitates information and data exchange within the industry. Commercial practices are readily compared with historical Navy practices when knowledgeable persons participate in meaningful meetings and support projects aimed at collecting the data required to make informed business decisions.

REFERENCES

NAVSEA 2005, 50% Relative Humidity Requirement for US Navy Shipboard Critical Coated Areas

NSRP 2009, Assessing the Need for 50% Relative Humidity During Tank Painting

NSRP 2008a, How to Inspect Flash Rust, a Training Manual

NSRP 2008b, Fast Track Single Coat Preservation System

NSRP 2007a, Review of Acceptable Flash Rusting for Ship Coatings

NSRP 2007b, Improved Rules for Painting US Navy Ships During New Construction and Repair

NAVSEA Standard Item 009-32, Cleaning and Painting Requirements; accomplish


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