Acquisition Directorate
Research & Development Center

Corrosion Control Roadmap

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Homeland Security

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16. Abstract (MAXIMUM 200 WORDS)

The USCG Corrosion Control Roadmap is a study of existing corrosion control procedures for the Product Lines within the USCG with an emphasis on finding corrosion abatement technologies that are not currently employed by the USCG. The report outlines current USCG corrosion control measures, and then details the framework used to investigate commercial, government and military corrosion abatement technologies that are not being utilized by the USCG at this time. The "new" items were assessed in conjunction with the Corrosion Prevention and Control (CPAC) working group to develop a list of coatings or technologies that will be evaluated on USCG platforms during the limited user evaluation phase of the project.
A final report that includes the results of the evaluation and any recommendations moving forward will be issued.
The final report will also include the results of an investigation into remote buoy corrosion monitoring systems and an assessment of cutter hull recoating intervals.

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EXECUTIVE SUMMARY

The Corrosion Investigation and Roadmap project is an effort to identify corrosion abatement technologies that are not currently utilized by the USCG. The effort is based on a problem statement submitted by Surface Forces Logistics Center (SFLC) Engineering Services Division (ESD) to the Research & Development Center (RDC) through the Center's project development ideation process. The main goal of the project was to identify high Technical Readiness Level (TRL) corrosion abatement technologies that are not currently being utilized, and determine if any of the new technologies impact USCG corrosion control in a positive manner.

The framework of the project was separated into three concurrent investigation phases and then an evaluation phase. The first phase investigated commercially available corrosion abatement technologies that the USCG is not using. That task was accomplished by publishing a Request for Information (RFI) to commercial sources requesting technologies or coatings that address the USCG corrosion drivers and performing additional market research. The second investigative phase included coordinating with other US military maritime organizations (Navy & Army) to determine if they are using corrosion technologies that the USCG is not. This was accomplished by contacting and participating in the Navy Community of Practice (CoP) Corrosion working group (which is the Navy's investigative group for new corrosion abatement technologies and solving corrosion issues for the Fleet). The third phase investigated current academic or Other Government Agencies (OGA) initiatives that may be applicable to the USCG's corrosion needs. This was accomplished by soliciting input from organizations like Naval Research Lab (NRL) & Oak Ridge National Laboratory (ORNL) to assess their current high TRL initiatives and decide if they were applicable to the USCG needs.

From these investigative phases, a list of possible evaluation items was presented to the Corrosion Control and Prevention (CPAC) working group. Evaluation items were down-selected for possible inclusion into the Limited User Evaluation (LUE) phase of the project.

The following items are proposed for assessment during the LUE on various Medium Endurance Cutters throughout the USCG.

1. One Component Polysiloxane (1K) coatings.
2. Fluidized Bed Re-coating of watertight doors.
3. Fast Clad Epoxy ER.
4. Composite Material Components for deck drains/electrical boxes.

The LUE will occur on various Medium Endurance Cutters (MEC) throughout the USCG and will last for approximately 1 year for each item. At the end of that period, the items will be evaluated against existing methods. A final report will be issued detailing the results of the evaluation and make recommendations on whether to utilize these technologies moving forward.

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ACL	Authorized Chemical List
ASTM	American Society for Testing and Materials
AMCOM	Army Aviation & Missile Life Cycle Management Command
CCSE	Center for Corrosion Science & Engineering
CG	Coast Guard
CGC	Coast Guard Cutter
COMDTINST	Commandant Instruction
CAGE	Commercial and Government Entity Code
CoP	Community of Practice
CM	Corrosion Manager
CPA	Corrosion Prevention Advocate
CPAC	Corrosion Prevention and Control
CPAC WG	Corrosion Prevention and Control Working Group
CER	Cutter Engineering Report
DOD	Department of Defense
DON	Department of Navy
EC	Engineering Change
EO	Engineering Officer
ESD	Engineering Services Division
FRC	Fast Response Cutter
FRP	Fiber reinforced plastics
GFE	Government Furnished Equipment
GFI	Government-furnished information
HRSCA	High Ratio Co-Polymerized Calcium Sulfonate
LUE	Limited User Evaluation
LCI	Logistics Compliance Inspection
LREPL	Long Range Enforcer Product Line
MPC	Maintenance Procedure Card
MP	Maintenance Program
MEC	Medium Endurance Cutter
MECPL	Medium Endurance Cutter Product Line
Mil-Spec	Military Specification
NAICS	North American Industrial Classification System
NSN	National Stock Number
NRL	Naval Research Laboratory
NDI	Non Destructive Inspection
OGA	Other Governmental Agencies
ORNL	Oak Ridge National Laboratory
PE	Port Engineer
PEI	Polyethermide
PL	Product Line
PLCPA	Product Line Corrosion Prevention Advocate
PDM	Programmed Depot Maintenance

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS (Continued)

QPL	Qualified Products List
QA	Quality Assurance
RDC	Research & Development Center
RFI	Request for Information
R&D	Research & Development
SW	Sherwin Williams
SFLC	Surface Forces Logistics Center
SSB	Survivability & Sustainment Branch
TARDEC	Tank Automotive Research & Development Engineering Center
TRL	Technical Readiness Level
TCTO	Time Compliance Technical Order
USCGA	United States Coast Guard Academy
USCG	United States Coast Guard

1 INTRODUCTION

1.1 Background/Genesis of Project

The Corrosion Control and Monitoring project started after a new R&D "ideation" regarding corrosion abatement was submitted through the USCG Research & Development Center (RDC) ideation process. From the problem statement in the ideation, a framework on how to approach the issue was developed and the project was initiated.

The ideation problem statement is "*Corrosion is a major issue for all surface assets in terms of maintenance costs and lost operational hours. The Coast Guard needs* ***better coatings and better methods*** *to monitor corrosion damage*."

After working with the sponsor, Office of Naval Engineering CG-45, it was decided that the Surface Forces Logistics Center (SFLC) Corrosion Prevention and Control (CPAC) Working Group would be the main stakeholder and conduit for project ideas, meetings and decisions. The RDC framework /outline for addressing the project were as follows:

1. Document current USCG corrosion prevention processes.
2. Perform market research into commercial practices not currently employed by USCG.
3. Investigate/coordinate other Military branches corrosion practices.
4. Investigate Other Governmental Agencies corrosion initiatives.
5. Down-select technologies/coatings for possible evaluation.
6. Develop Corrosion Roadmap outlining findings and evaluation items (RDC Product).
7. Conduct Limited User Evaluation (LUE) of selected technologies.
8. Investigate Cutter Hull re-coating intervals and compare to commercial practices.
9. Investigate remote buoy corrosion monitoring systems.
10. Final Report documenting evaluation items results (RDC Product).

1.2 Corrosion Principles

Corrosion is defined as the environmental deterioration of any material, metallic or non-metallic, and includes the environmental degradation of all materials. Ordinarily, corrosion is associated with metallic materials that are in the process of reverting to their natural states (oxides, carbonates, etc.). Some metals and metalloids (graphite, for example) are not corrosion prone, but they will cause and accelerate corrosion on less noble metal in contact with them. For this reason, all metallic materials used any marine system should be protected from the environment by the selection and use of the proper metallic and non-metallic materials (Reference 1).

The USCG is concerned primarily with these types of corrosion that occur within the marine environment: (Reference 1)

- *General Surface Corrosion (Uniform Attack) - Corrosion occurring at the same rate over much of the surface area is considered a uniform or general corrosion. General overall corrosion is not too great a concern because it can be predicted and proper materials selection and the use of adherent coatings can preclude this particular corrosion mechanism from occurring. However, uniform corrosion will rapidly attack corrosion sensitive materials should the coating become nicked or scratched.*

- *Galvanic Corrosion - In general, materials at the top of the Galavanic tables list (e.g., gold, titanium and silver) are corrosion resistant while those at the bottom (e.g., aluminum, zinc and magnesium) are not. Additionally, when two different metals or alloys come in contact with each other, the one that is closest to the top of the table is cathodically protected while the one closest to the bottom becomes anodic and as a result, corrodes. Metals that are listed near each other on the table show far less sensitivity to galvanic corrosion than those that are far apart.*

Table 1. Galvanic corrosion.

Anodic (Corrodes) \ Cathodic	Magnesium & Alloys	Zinc & Alloys	Aluminum & Alloys	Cadmium	Steel (Carbon)	Cast Iron	Stainless Steels	Lead, Tin & Alloys	Nickel	Brasses, Nickel-Silvers	Copper	Bronzes, Cupro-Nickels	Nickel Copper Alloys	Nickel-Chrome Alloys	Titanium	Silver	Graphite	Gold	Platinum
Magnesium & Alloys																			
Zinc & Alloys																			
Aluminum & Alloys																			
Cadmium																			
Steel (Carbon)																			
Cast Iron																			
Stainless Steels																			
Lead, Tin & Alloys																			
Nickel																			
Brasses, Nickel-Silvers																			
Copper																			
Bronzes, Cupro-Nickels																			
Nickel Copper Alloys																			
Nickel-Chrome Alloys																			
Titanium																			
Silver																			
Graphite																			
Gold																			
Platinum																			

GALVANIC CORROSION RISK

(Table from StructX resource)

- *Crevice Corrosion - Corrosion that occurs next to or inside a tightly occluded area is referred to as crevice corrosion. This form of corrosion occurs when a liquid corrosive is trapped in a gap between two components, in which at least one is sensitive to this form of corrosion. The gap must be sufficiently narrow (< 1/8 inch) to maintain a stagnation zone. Once this zone is established, the concentration of the corrosive increases as the corrosion reaction takes place. There is a long incubation process, from 6 months to a year, before the reaction commences. However, after initiation the reaction proceeds at a continuously increasing rate. Metals and alloys that rely upon oxide films or passive layers, such as stainless steels, for corrosion resistance are particularly susceptible to crevice corrosion.*

- *Pitting - Corrosion that has the appearance of pin holes or cavities is referred to as pitting corrosion. This form of corrosion is very destructive since it can cause failure with only a small percent weight loss of the actual structure. The pits themselves are actually cavities with a diameter that is less than or equal to its depth. The pits can grow to such a depth that they perforate the component in question. Failures resulting from pitting corrosion are almost entirely caused by chloride and chlorine containing ions. Stainless steels are more susceptible to this form of corrosion than any other class of metals or alloy*

- *Inter-granular Corrosion - Three different factors can make an alloy susceptible to this type of corrosion. These factors include impurities at the grain boundaries, enrichment of one of the alloying elements, or depletion of one of these elements in the grain boundary area. Intergranular corrosion occurs when the impurities along the grain boundaries are removed as a result of the corrosive environment. The result is that the individual grains not tightly bonded together fail along the grain boundaries with little applied stress. Intergranular corrosion can occur through the grains.*

- *Erosion Corrosion -This form of corrosion results when there is movement of one medium adjacent to another that removes the protective material such as surface oxide coating. The moving mediums can be a liquid or slurry such as fluid flow through a pipe. Turbulent flow, or cavitation, is especially destructive; the erosion corrosion can be particularly extreme when occurring at an area also subject to galvanic corrosion. The second form of erosion corrosion is fretting corrosion that occurs by movement of the contact region between two solid materials. This form of corrosion can be induced by vibration or by thermally induced expansion and contraction of materials with different coefficients of expansion.*

- *Selective Leaching-This form of corrosion results when one element from a solid alloy is removed through a corrosion process. The most common example is when zinc is removed from brass alloys. Other elements that can experience similar processes include aluminum, iron, cobalt, and chromium. These elements can be removed when the alloys containing them are exposed to aqueous acid*

- *Stress Corrosion Cracking - Stress corrosion requires the material in question to be under a tensile stress and also to be exposed to an environment that will initiate cracks within the stressed part. The stress can be as low as 10% of the yield stress for certain alloys and up to 70% for others. Loads applied by mounting bolts, in-service conditions, or even manufacturing processes such as welding can induce stress corrosion.*

1.3 Current USCG Corrosion Control Measures

Corrosion prevention and control in the USCG is achieved by the application of proper engineering design, Quality Assurance (QA), Nondestructive Inspection (NDI) and correct manufacturing during construction of cutter and boat platforms. In addition, operations & maintenance to prevent the start of corrosion and systems that define processes for the tracking and repair of corrosion problems are important measures to control corrosion.

Coast Guard (CG) cutters and boats are operated and maintained in an extremely corrosive environment. Many cutters are well into or beyond their intended service life where corrosion can become a major cost of ownership. As cutters and boats age, the cost of corrosion in terms of dollars and mission readiness continues to increase and escalate (Reference 1).

1.3.1 Corrosion Prevention & Control (CPAC) Guidance

Commandant CG-45 provides program policy, processes and oversight for the CPAC Program. The responsibility for CPAC Program lies within the Surface Forces Logistics Center (SFLC) Engineering Services Division (ESD) Survivability & Sustainment Branch (SSB) Maintenance Programs Section (MP). USCG Guidance and responsibilities for the Product lines are delineated within SFLC CPAC Process Guide CGTO 85-00-60-S (09 September 2016).

A summary of corrosion related responsibilities and requirements are outlined below:

1.3.2 Corrosion Prevention & Control Working Group (CPAC WG)

The purpose of the CPAC Working Group is implementation of the CPAC Program and to provide recommendations regarding corrosion abatement procedures. The governing documents and references for corrosion control, coatings maintenance/evaluation, surface preparation/application of authorized coatings and deck coverings within the USCG are:

COMDTINST M10360.3 (series) - Coatings and Color Manual (Reference 2)
SFLC Standard Specification 6310 - Requirements for Preservation of Ship Structures (Reference 3)
SFLC Technical Standard 631 – Coatings Evaluation and Maintenance (Reference 4)
SFLC Standard Specification 6341 – Install Interior Deck Covering Systems (Reference 5)
SFLC Technical Standard 634 – Interior Deck Coverings (Reference 6)

The CPAC WG meets at least annually (more often if needed) and consists of the following Permanent and Ad Hoc members: (Reference 1)

- Permanent:
  - *Corrosion Manager (CM).*
  - *Product Line Corrosion Prevention Advocates (PLCPA).*
  - *Coast Guard Yard representative.*
  - *A Port Engineer representative selected on a rotational basis from the Product Lines.*

- Ad Hoc Members available to address specific issues:
  - *Product Line Engineering Section representatives.*
  - *Engineer Officer or Engineer Petty Officer from each Product Line.*
  - *Unit CPAs.*

1.3.2.1 *Corrosion Manager (CM) Responsibilities*

- Ensure cutter and boat systems, equipment, and components are designed to minimize corrosion.
- Review and evaluate emerging corrosion prevention technologies for cutters, boats, and support equipment.
- Provide technical assistance to the Product Lines to develop corrosion Maintenance Procedure Cards (MPC).
- Respond to feedback regarding corrosion issues, instructions and procedures.
- Ensure that maintenance policies, procedures and programs include adequate corrosion prevention and control guidance.
- Ensure the Coast Guard is represented at corrosion program meetings, and participates in DoD/DoN corrosion control programs to leverage DoD/DoN and industry best practices.
- Coordinate SFLC Engineering Board and CPAC Program Working Group meetings.
- Facilitate communication between the field units Corrosion Prevention Advocate (CPA) and their respective Product Line Corrosion Prevention Advocates.(Reference 1)

1.3.2.2 *Product Line Corrosion Prevention Advocates (PLCPA)*

Each USCG Product Line has a PLCPA appointed by the Product Line Manager. Product Lines represented include:

– Long Range Enforcer Product Line (LREPL).
– Medium Endurance Cutter Product Line (MECPL).
– Patrol Boat Product Line (PBPL).
– Ice Breaker/Buoy & Construction Tender Product Line (IBBCTPL).
– Small Boat Product Line (SBPL).

PLCPAs will:

- Support each Product Line with corrosion issues and are located in each Product Line.
- Maintain a roster of all Unit CPAs within the Product Line.
- Provide an annual report (due NLT 1 May of each year) to the CM.
- Ensure that the Product Line develops and maintains a Product Line CPAC Plan.

- Have sufficient knowledge and experience in the Corrosion Control Field to:
  - *Manage and implement new corrosion prevention technologies.*
  - *Address recurring corrosion problems.*
  - *Make recommendations for reducing corrosion-related expenditures.*
  - *Provide direct liaison with each Product Line.*
- Report progress of programs, current initiatives, and problem areas to the appropriate Product Line Manager.
- Coordinate CPA activities with the CM for the incorporation of new corrosion technologies.
- Assist in the development of testing procedures for the validation of new technologies.
- Initiate or assist in the development of corrosion-related procedural changes (CG-22), Time Compliant Technical Orders (TCTO), etc.
- Participate in the Logistics Compliance Inspection (LCI) to evaluate CPAC Program compliance. When it is not feasible to attend every LCI due to the number of vessels, PLs will designate a local PE to assume this role.
- Perform spot checks of cutters and boats during Programmed Depot Maintenance (PDM) to assure compliance with required corrosion prevention maintenance.
- Analyze corrosion assessment data for trends.
- Regularly brief the appropriate Product Line Engineering Branch Leader and the CM on current status of corrosion concerns as addressed at PDM.
- Attend conferences, corrosion-related meetings and seminars as directed. (Reference 1)

1.3.2.3 *Unit Corrosion Prevention Advocate (CPA).*

Each unit has a CPA designated in writing by the unit Engineer Officer (EO). For purposes of the CPAC program, all cutters are defined as being a unit.

The Unit CPAs shall:

- Report directly to the Engineer Officer or Engineer Petty Officer.
- Coordinate quarterly training on corrosion prevention for unit maintenance personnel.
- Spot check technicians to ensure that inspection and corrective action corrosion MPCs are being performed correctly.
- Inspect power tooling to ensure that it is being maintained properly for safe, effective operation.
- Inspect the paint locker to ensure that:
  - *All coatings stored and used by the unit are listed on the Authorized Chemical List (ACL) and authorized by SFLC Standard Specification 6310.*
  - *Coatings are properly stored and sealed to prevent solvent loss and degradation of the coating.*
  - *Expired and unauthorized coatings are properly disposed of.*
- Recommend changes to the ACL and/or SFLC specifications via CG-22s or Contract Workbook feedback, as applicable.
- Make recommendations to the PLCPA for improving the CPAC Program.
- Make recommendations for changes to Maintenance Procedure Cards (MPCs) to improve the CPAC program.
- Submit a report (due 31 January of each year) in conjunction with Cutter Engineering Report (CER) through the chain of command to the PLCPA. (Reference 1)

2 FRAMEWORK OF CORROSION INVESTIGATION

2.1 Corrosion Drivers within the USCG Product Lines

The CPAC PLCPAs are required to produce an Annual Report that includes the major corrosion issues within each product line. The RDC reviewed the last several annual reports per product line for commonalities (or corrosion drivers) across all Product Lines. In addition, the RDC solicited each PLCPA for input on the top corrosion drivers within their Product Line (PL). The intent was to direct the market research towards those drivers. The following areas of corrosion concern were common through the Product line annual reports:

1. Water tight doors and hatches.
2. Bilges/tanks.
3. Areas behind insulation.

This is not an exhaustive list of corrosion problems within the USCG but the common issues across most of the Product Lines.

2.2 Market Research

2.2.1 Request for Information (RFI)

A Request for Information (RFI) was published in FED BIZ OPPS on 20 March 2017 and closed to submissions on 12 May 2017. The RFI was developed so that solutions to the USCG corrosion drivers would be solicited.

The RFI solicited advancements in:

(1) commercial corrosion control coatings;

Marine Coating Systems that provide advanced corrosion control and address current USCG corrosion problem areas identified below:

a. Watertight doors & hatches
b. Bilges
c. Tanks
d. Hidden areas behind insulation or walls
e. Deck fittings

(2) non-destructive corrosion inspection methods for USCG boats and cutters, specifically in the following general areas;

Nondestructive (ND) Corrosion Inspection methods that improve Coast Guard corrosion detection, specifically for hidden areas without removing coverings or obstructions such as insulation or sheathing.

The RFI stated that ships operated by the United States Coast Guard experience operating conditions significantly more demanding than commercial counterparts. Coatings that perform suitably in those applications may fail prematurely in CG service, leading to excessive recoating and maintenance costs. For these reasons, the CG has established its own list of approved coatings for generic categories. The USCG accepts military specification (mil spec) and Qualified Products List (QPL) coatings for those applications and areas where their past performance has been acceptable. However, constant advances in coating technology create new, high-performance coatings that are likely to produce significant performance enhancement and/or cost savings. Therefore, the CG has also approved commercial coatings for those applications and areas where Mil-Spec/QPL coatings have not performed well, and has placed them on the list of approved coatings. **The RFI did not solicit submissions for coatings already on the USCG approved lists.**

The RFI was posted referencing the North American Industry Classification System (NAICS) Code 32551 – Paint and Coating Manufacturers to notify coating manufacturers listed under that NAICS code. In addition, a specific list of Coatings Manufacturers, based on market cpaitilization, was developed and the RFI was sent to them specifically for their review and response. The list of manufacturers that the RFI was specifically emailed to is noted in Table 2.

Table 2. Coatings manufacturers.

PPG
Azko Nobel
Sherwin Williams
Sika, USA
RPM International
Nippon, USA
Valspar
Axalta
Kansai Paint
KCC - Marine Coatings
3M
Masco
Benjamin Moore
Lord
Ennis-Flint
Kelly-Moore
Diamond Vogel
Whitford Corporation

The entire RFI solicitation is included in Appendix A.

2.2.2 RFI Submittals Received

The initial RFI period for submissions was extended from the original one (1) month period for an additional three weeks so submitters could have more time and for the USCG to gather more responses. The submittals received were underwhelming in regards to quantity and also how they addressed the specific USCG corrosion needs or drivers as noted in the RFI. There were no submittals regarding NDI methods. Recall, the RFI only solicited new corrosion methods that are currently not being utilized.

The results received from the RFI are summarized below and will be further detailed in a later section of this report as noted.

Submittal 1 – 3M Industries Email

1. An email from 3M Industries which did not address the RFI questions but gave POCs for any questions. This submittal did not meet the USCG submittal requirements and will not be discussed further in this report.

Submittal 2 – HYDREX Underwater Technology

1. Eco speed – Underwater Hull protection for corrosion and as an anti-abrasion for Ice-going vessels.
2. Eco shield – Corrosion protection for underwater areas of vessels.

Submittal 3- Sherwin Williams

1. Fast Clad ER – Sherwin Williams suggested using their product as a single coat application instead of two coats as currently approved with a fluorescent pigment added for inspection purposes.

2.3 Coordination with other Military Services/ Other Government Agencies (OGAs)

The framework of the Corrosion investigation included determining if other military services and OGAs were utilizing corrosion abatement technologies that the USCG was not. The RDC team first solicited other corrosion labs in the military and OGAs. The primary goal was to identify new technologies or products that could be utilized by the USCG. As part of this research, the RDC contacted the Navy and the Army to solicit their input and find out if they had success with corrosion abatement technologies that the USCG is not using. In addition, investigation into OGA initiatives and that address the identified USCG drivers was conducted.

2.3.1 NAVY

2.3.1.1 Navy Corrosion Community of Practice (CoP)

The Navy Corrosion CoP's mission is to mitigate corrosion across the Navy surface fleet beginning from design and then throughout a ship's life cycle. The CoP is comprised of Navy members from the operator, maintenance execution, maintenance planning, engineering, research and development, and program management organizations to ensure that a multi-disciplined, comprehensive approach is followed in serving the Navy Fleet. The CoP's goal is to provide a unified approach to identify, assess and address corrosion problems facing the Navy surface fleet through an integrated reporting structure and process, which selects mitigation efforts for investment in accordance with Fleet needs.

The CoP conducts monthly telecoms and face-to-face meetings at least once per year. There are several current working groups (i.e. logistics; aluminum maintenance) tasked by the Navy Cop leadership to investigate Navy Corrosion problem areas that have been brought to their attention.

Based on RDC participation in these Navy CoP telecoms and meetings, several specific corrosion evaluation items were identified for assessment. These items are currently not utilized by the USCG were identified. The Navy CoP corrosion evaluation items are listed below and will be discussed later in the report.

1. One component (1K) Polysiloxane coatings.
2. Composite material components.
3. Fluidized bed re-coating of watertight door and louvers.

2.3.1.2 Naval Research Laboratory (NRL)

The Center for Corrosion Science & Engineering (CCSE) of the NRL conducts broad scientific and engineering programs to understand and reduce the effects of the marine environment on Naval systems. The Corrosion Science Section aims to increase understanding of corrosion mechanisms through the study of passive films and their breakdown. The Corrosion Engineering Section operates the Marine Corrosion Facility in Key West, FL that provides engineering solutions to Navy corrosion control problems. Specific expertise in cathodic protection systems, alloy exposure and testing, seawater system corrosion and fouling control and aquatic nuisance species test and evaluation are maintained at the Key West facility. The Marine Coatings Section operates as part of the lab in Key West and partly in Washington DC, with a focus on the evaluation of shipboard coatings and development of new resin technology.

NRL was contacted to see if any they currently had initiatives that would address the USCG needs. It was determined that NRL CSE could be used as a resource during the limited user evaluation if specialized testing and or expert guidance is required.

2.3.2 Army/Oak Ridge National Laboratory (ORNL)

The Army, in conjunction with Oak Ridge National Laboratory, has several corrosion initiatives that are of interest to the USCG at this time.

1. The Corrosion Science & Technology Group of ORNL on behalf of the Army Aviation & Missile Life Cycle Management Command (AMCOM) is investigating the characterization of coatings containing carbon nanotubes and metal particles applied directly to aluminum and steel substrates. A follow on project will study coatings of various thickness and the corrosion and adhesion performance of these coatings.
2. ORNL is also working with the Army Tank Automotive Research & Development Engineering Center (TARDEC) in evaluating cadmium and chromium as additives in corrosion resistant coatings in salt atmospheres for steel and aluminum substrate of tanks.

The RDC will follow the results of these studies and include relevant information in the final RDC report.

2.4 Evaluation Items Descriptions

The RDC and the CPAC WG assessed various corrosion abatement technologies discovered during the investigations. As noted earlier, these items were found during market research, coordination with other military branches or input from the sponsor (CPAC WG). The items were then assessed on their ability to prevent corrosion. A focus of this investigation included finding technologies that the USCG does not currently utilize. A list of the technologies, how they came to our attention and a brief description follows;

2.4.1 Single Component (1 K) Polysiloxane – Navy CoP & CPAC WG

NCP Coatings and the Naval Research Laboratory (NRL) developed a single component polysiloxane topcoat for the US Navy. The coating is a single component, meaning it is not required to mix two parts to form a finished product. It is based on novel polymer that reacts with moisture to eliminate alcohols when cross-linking/curing. The USCG currently uses two component polysiloxane coating systems as approved in SFLC specification 6310. The new 1 K polysiloxane complies with military specification MIL PRF-24635 (Coating System, Weather Resistant, Exterior Use).

Features and benefits of the 1K polysiloxane coating system as noted by the manufacturer include:

- No mixing of multiple components before application.
- Can be applied multiple times until the can is exhausted, minimizing HAZMAT.
- Keeping the can sealed or tightly closed will extend the usable life of the coating.
- Can be applied by roll, brush or spray.
- Adheres to epoxy primers and aged/prepared silicone alkyds/2K polysiloxane.
- Environmentally friendly – isocyanate-free, HAPS-Free, and low in VOCs.
- Uses the new Naval Research Lab LSA pigment package for enhanced color.
- Out-performs qualified silicone alkyds and 2K polysiloxanes with regard to color stability.
- Qualified to MIL-PRF-24635E, Type V requirements.
- Could field apply over silicone alkyd with preparation.

A manufacturer developed product information sheet is included in Appendix B.

2.4.2 Composite Material Components – Navy CoP

Composite material components offer the potential to be more resistant to environmental effects, lighter weight and in some cases lower cost than the legacy metallic components. The Navy has made significant progress on fielding some components such as weather deck grating, deck drains, and electrical boxes. Each composite component has been tested to Navy standards and many components are installed and deployed on Navy ships. Several different manufacturers produce the components and NSN /CAGE numbers for ordering purposes lists each part. Examples under consideration for evaluation on CG cutters are shown below with the composite material in parentheses (Reference 2);

2.4.2.1 Composite Electrical Enclosures: (Material -Glass/Polyethermide)

(Photo from Naval Surface Warfare Center-Carderock Division)

Figure 1. Composite material electrical boxes.

2.4.2.2 Composite Deck Drains- ULTEM 2300 (30% chopped glass Polyetherimide (PEI)

Navy design includes drain insert from composite material with twist lock and then install the fasteners permanently.

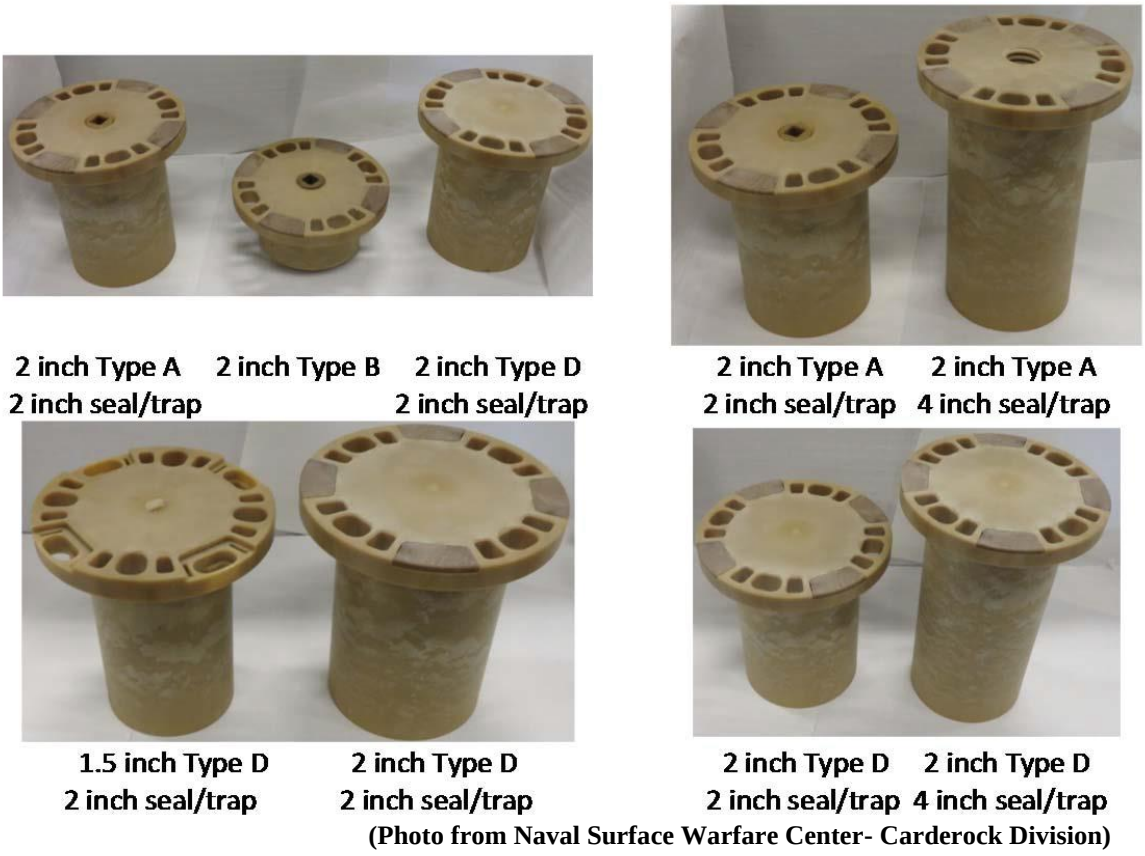

Figure 2. Composite material deck drains.

For the purposes of the current limited user evaluation (LUE) the RDC will try to utilize existing composite components (deck drains or electrical boxes) produced by Navy for an evaluation installation on CG Cutter. The installation for the LUE is dependent on finding an exact match of a composite deck drain or appropriate electrical box. The RDC and the CPAC WG is working with the MECPL to identify exact matches of the composite material components.

In addition, during the LUE, the RDC will continue to solicit input from the CPAC WG and Product Lines to determine specific components on Cutters that are corrosion problem areas and are suitable for new composite component development using Navy process steps outlined below. Again, the RDC will continue to stress any new composite component development meets USCG corrosion problem areas.

1. Identification of Target components.
2. Requirements definition.
3. Prototype fabrication, evaluation & demonstration.

A complete list of the currently available composite components from the Navy Surface Warfare Center - Carderock Division is included in Appendix C.

2.4.3 Fluidized Bed Coating of Watertight Doors – Navy CoP

In 2010 the US Navy started investigating water tight door corrosion problems by looking at various coating methods including fluid bed powder coating, electrostatic powder coating, high solid liquid and E-coating. From this investigation, the Navy decided to pursue fluidized bed coating as an alternative to spray powder coating. Fluidized bed coating is unique **patented** process due to a porous membrane plate, which uniformly diffuses air throughout the coating powder which then behaves like a fluid so that the particles distribute themselves over the entire surface of the preheated component (watertight door). The Navy is building their own organic facilities (1 east coast, 1west coast) to use the process on certain sizes of watertight doors. The majority of the problems with existing coated watertight doors are within the channel seal where corrosion exists and can damage the structural integrity of the door.

(photo from Navy Community of Practice (CoP))

Figure 3. Watertight door corrosion.

Information from the manufacturer on the Fluidized bed recoating process is included in Appendix D

2.4.4 Sherwin Williams Fast Clad ER Epoxy with Fluorescent Pigment - RFI

Sherwin Williams (SW) proposed in an RFI submission that the USCG consider using the SW "Fast Clad ER" two-coat system as a single coat system for specific applications including ballast and fuel tanks and bilges. The coating system is an edge retentive, ultra-high solids epoxy amine coating engineered for service in sea water ballast tanks, fuel sea water ballast tanks and fuel storage tanks. SW states that single coat

system is qualified to MIL PRF-2223. A fluorescent pigment in the coating is used for inspection purposes post application to identify any poor application areas. A special blue light is used to identify the poor application areas.

Fast Clad ER Epoxy is approved in SFLC Specification 6310 as a two-coat system (primer & topcoat) for:

1. Fuel and/or Ballast Tanks, High Solids, Edge-Retentive (applied at Temperature > 50 F) (Type VII/Class 5 /Grade C).
2. Grey water sewage and CHT tanks, High solids, Edge-Retentive (applied at Temperature > 50 F) (Type VII/Class 13 /Grade C).

Sherwin Williams states that the Navy currently applies in a single coat at 20-30mls and saves application time and overall costs (material costs increase, application cost decrease, facility availability increases). SW states that the coated surface can be placed into service in 24 hours and has a 15-20 year life expectancy. The coating and has been applied in thousands of applications throughout the Navy fleet.

The product information and Application bulletin are included in Appendix E.

2.4.5 Terma-rust – CPAC WG

Terma-rust is an high ratio co-polymerized calcium sulfonate (HRCSA) primer / topcoat encapsulation product. It is designed mainly for emergency repairs while underway to encapsulate severe corrosion until permanent repairs can be made. Discussions during the IPT down-select meeting eliminated this product from further evaluation. The CPAC WG indicated that this product was evaluated previously and that results were not satisfactory.

The Terma-rust product sheet is included in Appendix F.

2.4.6 ECOSPEED / ECOSHIELD- RFI

Eco-Speed and Eco-Shield are commercial coatings consisting of a vinyl ester resin base reinforced with glass platelets providing hull protection and antifouling properties. The application of these products to hulls reduce the hull roughness to less than 20 microns and produce a “hard coating”. The manufacturer states that these coatings have been used in the industrial settings for years and have been adapted for marine use specifically for Icebreaker coatings and for hulls that can be cleaned often. The manufacturer claims that they use manual cleaning instead of toxic chemicals (anti-fouling agents in coatings) to keep hulls free of growth, therefore increasing time required between hull re-coatings.

The RDC will investigate these coatings in more detail and depth during the final report stage of this project, specifically during the Cutter Hull recoating validation study.

The technical information for ECOSPEED is included in Appendix G and ECOSHIELD is included in Appendix H.

2.5 Down Select of Evaluation Items for Operational Evaluation

The evaluation items were compiled and presented to the CPAC working group at a down select meeting. Discussions during the down select meeting included the benefits and applicability of each technology to

existing USCG corrosion problems and drivers and whether the CPAC WG had previously evaluated them as solutions. In addition, discussions centered around whether these coatings or technologies had been proven previously on other maritime assets and whether they were high TRL solutions ready for immediate use. These deliberations yielded a list of proposed evaluation items that will be the basis for the RDC's Limited User Evaluation (LUE) on various USCG Medium Endurance Cutters (MEC).

1. ***1 K (Component) Polysiloxane for topside coating.***
2. ***Fluidized Bed Coating of Watertight Doors.***
3. ***Sherwin Williams Fast Clad Epoxy w florescent pigment.***
4. ***Composite Material Components:***
   a. ***Deck Drains.***
   b. ***Electrical Boxes.***

3 LIMITED USER EVALUATION PROCESS

The RDC plans to evaluate each of the selected corrosion technologies using a Limited User Evaluation (LUE) process. Each item will be installed on various Medium Endurance Cutters (MECs) during previously scheduled maintenance availabilities. The RDC is working with MEC Product Line (MECPL) Program Depot Maintenance (PDM) branch to determine the specific cutter platform for each evaluation item, the proposed timeframe and how each item will be installed.

3.1 Installation

The LUE process will involve a combination of SFLC contracted work combined with RDC contracted items. The SFLC MECPL Program Depot Maintenance (PDM) section manages the maintenance contract work for all MECs. Currently, based on the evaluation items selected and the MECPDM scheduled maintenance availabilities, the following LUE schedule is proposed.

Table 3. Proposed plan for LUE.

Evaluation Item	Proposed Cutters	Proposed Dates	Approximate Quantity	Approximate Location
1.) 1K Polysiloxane	210 -STEADFAST	Sep-Nov 2018	400 SF - Topside	Frame X- Frame X
	270- SPENCER	Mar-May 2019	400 SF - Topside	Frame X-Frame X
2.) Fluidized Bed Re-coating of Doors	270 - MOHAWK	Aug-Oct 2018	2 WT Doors	TBD
	270 – HARRIET LANE	Sep -Nov 2018	2 WT Doors	TBD
	210 - VALIANT	May-July 2018	2 WT Doors	TBD
3.) Fast Clad ER	270- TAHOMA	Spring 2019	TBD	Bilge
4.) Composite Material Components				
Deck Drains	RDC/SFLC are trying to identify suitable candidates	TBD	TBD	TBD
Electrical Boxes	RDC /SFLC are trying to identify suitable candidates	TBD	TBD	TBD

The RDC will continue to work with the MEC PDM section to confirm schedules and availabilities regarding the installation of the evaluation items during the LUE. The final quantity and location of the evaluation items is an ongoing process and will be coordinated with the MECPL and the CPAC WG during the scheduling. The RDC has started the contracting process for materials and labor to supplement the MECPL PDM actions.

3.2 Configuration Approvals Needed

The RDC is working closely with the MECPL and SFLC ESD to ensure needed approvals to install the evaluation items. USCG (CG-22) forms for an Engineering Change (EC) recommendation will be submitted for each evaluation item, to track and document the details of the install. Once all required data is satisfactorily submitted to the approving authority, a prototype authorization memo will be issued to formalize the use of non-configuration items during the evaluation period.

3.3 Evaluation Parameters

3.3.1 How will Evaluation Items be Assessed

During and after an evaluation period of approximately a year for each proposed item, the RDC and CPAC WG will compare the performance of the evaluation items versus the previous method of coating or corrosion control. The evaluation interval for each item may vary depending on scheduling limitations, approvals to install, contracting issues and when they are actually installed and project constraints.

Evaluation criteria will include:

1. Photographic evidence.
2. Interviews with Port Engineers (PE), Engineering Officers (EO) and the ships force.
3. Other NDI testing methods to determine performance (Ultrasound inspection).
4. Direct comparison with existing coating methods.
5. Direct comparison with untreated surfaces.
6. RDC testing of sample coating coupons at USCGA corrosion lab

4 FUTURE ACTIONS ON THE CORROSION PROJECT

4.1 Hull Recoating Validation Study

The hull recoating validation study was added to the overall corrosion project during the last RDC ideation submittal cycle. The problem statement/ executive summary is noted below;

"As a part of depot level maintenance, the Coast Guard frequently abrasively/water blasts our cutters to bare steel every four to eight years, depending on cutter class. The commercial industry often goes 12 years between full blasts to bare steel. With the goal of at least maintaining current operational availability, the current blast and paint schedule should be reexamined and revalidated. Blasting, and abrasive blasting in particular, removes some amount of steel every time it is completed, does this removal increase how often large sections of hull must be cropped and replaced? It is expensive to paint an entire hull, would it be more cost effective to just crop and replace small damaged sections of the hull or coating system, where the coating system has failed, and would this have any effect on operational availability?"

The framework for answering this problem statement is as follows. The RDC will investigate and review depot level maintenance records across various cutter classes and determine if there are commonalities between the reasons for blasting hulls to bare steel. From data review and market research, the RDC will also verify the time intervals noted in the problem statement and compare to commercial time intervals. Conclusions and recommendations will be included in the final report.

4.2 Remote Buoy Corrosion Monitoring Systems

The remote buoy corrosion monitoring study was added to the overall corrosion project during the last RDC ideation submittal cycle. The problem statement/ executive summary is noted below;

"*The need is to remotely monitor the hull condition (wall thickness, extent of corrosion) of steel ocean buoys deployed on station. This would permit condition-based maintenance, rather than requiring scheduled inspections by buoy tenders. This can potentially reduce the cost of the Aids to Navigation (ATON).*

Currently, buoy tenders visit these aids on a scheduled basis (i.e., every so many years). Perhaps a buoy is in good condition and the inspection visit was unnecessary, or perhaps the buoy is in poor condition and the inspection should have happened sooner. In the first case, ship resources were wasted on an unnecessary visit. In the second case, inventory resources were wasted because the buoy was allowed to degrade and subsequent repairs will be that much more expensive."

The framework for answering this problem statement is that the RDC along with the USCGA will perform market research and determine if any commercial remote monitoring systems for buoy corrosion exist and if they could possibly fit the USCG needs. The RDC / USCGA will also investigate current academic initiatives for applicability to the USCG. Conclusions and recommendations will be included in the final report.

4.3 Final RDC Corrosion Report

Once the Limited User Evaluation period is complete, a final RDC report in conjunction with the CPAC WG will be developed and submitted. The final report will include the following:

1. Description and details of the installation of each evaluation item
2. Approvals necessary for prototype installation
3. Results of the evaluation for each item
4. Recommendations on whether to initiate further CG use of evaluation item
5. A reproducible methodology to support CPAC to review future evaluation items
6. Results and conclusions of the hull recoating validation study
7. Results and conclusions of the remote buoy corrosion monitoring system investigation

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5 REFERENCES

1 USCG. (2016). *SFLC Corrosion Prevention and Control (CPAC) Program Process Guide CGTO PG-85-00-60-S.* Washington DC.

2 USCG. (2014). *COMDTINST M10360.3D Coatings and Color Manual* . Washington DC.

3 USCG. (2014). *SFLC Standard Specification 6310: Requirements for Preservation of Ship Structures.* Washington DC.

4 USCG. (2014). *SFLC Technical Standard 631 – Coatings Evaluation and Maintenance.* Washington DC: Surface Forces Logistics Center.

5 USCG. (2014). *SFLC Standard Specification 6341: Install Interior Deck Covering Systems.* Washington DC.

6 USCG. (2014). *Technical Standard 634 – Interior Deck Coverings.* Washington DC: Surface Force Logistics Center.

7 Foley, D. M., & Park, R. (2017). *Composite Materials Components for Reduce Maintenance and Total Ownership Cost.* Maryland: Naval Surface Warfare Center, Carderock Division.

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APPENDIX A. REQUEST FOR INFORMATION

Marine Coating Systems Market Research

DESCRIPTION:

This Request for Information (RFI) is part of a market research effort by the United States Coast Guard (USCG) to assess advancements in corrosion control coatings and inspection methods, specifically in the following general areas;

(1) Marine Coating and Painting Systems that provide advanced corrosion control and address current USCG corrosion problem areas and are currently approved as a military specification (mil spec) and Qualified Products List (QPL) coatings. Coating systems that specifically are targeted for the following problem areas are requested but all new coatings will be reviewed;

a. Bilges
b. Ballast Tanks
c. Hidden areas behind insulation or walls

(2) Non destructive Corrosion Inspection methods that improve Coast Guard corrosion detection, specifically for hidden areas without removing coverings such as insulation or sheathing.

This RFI is issued for information purposes only and does not constitute a solicitation. The Government does not intend to award a contract on the basis of this RFI or to otherwise pay for information received in response to this RFI.

The USCG is conducting research to identify both operational and advanced prototype technologies that can meet these research areas. "Operational" in this context refers to existing coatings and equipment that are currently used in commercial and/or Government application, while "advanced prototype" in this context refers to proven and near-proven technologies that are expected to be available in the commercial and/or Government market in the next 12 to 18 months.
The USCG intends to use the information collected from this RFI to evaluate promising coatings and inspection technologies to see if they can improve current USCG Corrosion Prevention and Control (CPAC) processes.

BACKGROUND
Ships operated by the United States Coast Guard may experience operating conditions significantly more demanding than those seen by their other military or commercial counterparts. Coatings that perform suitably in those applications may fail prematurely in CG service, leading to excessive recoating and maintenance costs. For these reasons, the CG has established its own list of approved coatings for generic categories. The CG accepts military specification (mil spec) and Qualified Products List (QPL) coatings for those applications and areas where their past performance has been acceptable. However, constant advances in coating technology create new, high-performance coatings that are likely to produce significant performance enhancement and/or cost savings. Therefore the CG has also approved commercial coatings for those applications and areas where Mil-Spec/QPL coatings have not performed well, and has placed them on the list of approved coatings. The generic categories approved coatings list (which includes approved

commercial coatings) is available from SFLC. The military/federal specification and QPL approved coatings is available from SFLC. ***This RFI is not soliciting submissions for coatings already on the approved lists.***

USCG Surface Forces Logistic Center (SFLC) Standard Specification 6310; "REQUIREMENTS FOR PRESERVATION OF SHIPS STRUCTURES" describes Cutter and Boat painting systems and Authorized coatings and is available upon request.

SPECIFIC TECHNICAL INFORMATION REQUESTED

Submissions can include new applications of proven technologies. This request is not seeking any low Technical Readiness Level (TRL) concepts. The following information, or best available estimate, is requested for each proposed product/technology. If multiple products/technologies are presented by the same entity, the information should be specific to each product/technology. Submissions shall be for complete systems, from the first coating on the substrate to the topcoat. If the requesting manufacturer does not produce all of the required components for a system, acceptable products from other manufacturers should be listed. The following questions/statements should be addressed for each product/technology described in your response to this RFI:

A. A point of contact within the company, including title, street address, phone, fax, and e-mail.
B. A brief description of the system, e.g., the intended use of the coating system, the number of separate coatings, and for each coating its name, chemical type, requirements for surface preparation, mixing, application, and thickness, and the minimum and maximum times for drying, intervals between coats, and recoating.
C. A Product Data Sheet for each of the coatings in the coating system.
D. A Material Safety Data Sheet for each of the coatings in the coating system.
E. Other federal approvals of the system or its components, such as mil spec. QPL, U. S. Maritime Administration (MARAD), or Military Sealift Command (MSC).
F. Additional relevant information, such as state and local approvals and certifications, and results of laboratory and accelerated tests.
G. What agencies, governments, or other maritime service providers currently use the product/technology you described? Has this technology been used in a maritime environment by boat operators?
H. If your technology is not currently available as a Commercial Off-the-Shelf product: Are there any development efforts or test activities currently underway or planned to mature your product/technology and/or assess its maturity?
I. Rough Order of Magnitude Cost – Initial purchase and maintenance costs.
J. Manufacturer Warranty – Multiyear warranty over estimated service life.
K. Please Identify if you are a Small or Large Business
L. Business Size with regard to NACIS 32551

The following are requirements for all coatings in CG service:

1. EPA registration for antifouling coatings.
2. Volatile Organic Content (VOC) limits of 400 grams/Liter for antifouling coatings and 340 g/L for all other coatings.
3. Listing on the Qualified Products List (QPL) for MIL-PRF-23236, Class 9 for potable water tank coatings.

The following are banned from CG service:

1. Coatings containing lead or other hazardous heavy metals. (Lead-free is defined in 16 CFR 1303-Ban of Lead-Containing Paint and Certain Consumer Products Bearing Lead-Containing Paint as 0.06% or less lead by weight in the dry paint film.)
2. Coatings containing coal-tar derivatives.
3. Coatings containing hexavalent chromium compounds, for example, zinc chromate and other chromates.
4. Antifouling coatings containing organotin compounds, for example, tributyl tin (TBT).
5. Coatings containing asbestos.
6. Coatings containing cadmium.

RESPONDING TO THIS MARKET RESEARCH

It is desired that responses to this RFI address all of the topics discussed in the 'SPECIFIC TECHNICAL INFORMATION REQUESTED.' Topics may be combined or treated individually. However, if information is not available for some of the topic areas, your submission is still of interest to the USCG.

When responding to the RFI, please include the following information:

- A one page cover letter that provides a brief summary of the response and indicating if supporting documentation is included.
- Amplifying information that addresses all areas of information requested by this RFI in sections "SPECIFIC TECHNICAL INFORMATION REQUESTED." If pre-developed marketing or technical information and specification sheets are provided, please include additional information, as necessary to "fill the gaps" between pre-developed material and the information required. Digital photographs, line drawings, and illustrations that clarify descriptive text are encouraged.
- A description of any information relative to what products/technologies are currently available and what additional products/technologies may become available over the next 12 to 18 months
- If multiple products/technologies are presented by the same entity, the responses to these questions should be specific to each product/technology.
- Provide a list of U.S. (or international) Government contracts for products/technologies where applicable
- Provide any digital photos and/or digital videos of the products/technologies in operation if able
- In order to fully analyze the responses please include justification / amplifying information (e.g. reports, videos, actual applications, etc.) which supports your responses.
- Please limit electronic responses to no more than 25 pages per product/technology (supporting documentation in the form of a glossary or attachments to the RFI response will not be counted towards the 25-page limit). If your RFI response is greater than 10 MB, please provide it on DVD media and mail it to:

ATTN: MS. HELEN CARNES, CONTRACTING DIVISION
U.S. COAST GUARD RESEARCH AND DEVELOPMENT CENTER
1 CHELSEA STREET
NEW LONDON, CT 06320-5506

This RFI is issued for information and planning purposes only and does not constitute a solicitation. The Government does not intend to award a contract on the basis of this RFI or to otherwise pay for information received in response to this RFI. In accordance with FAR 15.201(e), responses to this RFI are not offers and will not be accepted by the U.S. Government to form a binding contract. Responses to this market survey should be sent to RDC-SMB-MarineCoatingSys@uscg.mil.

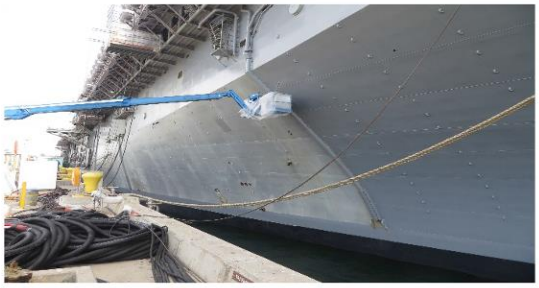
PHONE CALLS WILL NOT BE ACCEPTED, VOICE MAIL MESSAGES LEFT WILL NOT BE RETURNED AND EMAILS WILL NOT BE RESPONDED TO.

Information submitted will be reviewed by Government personnel only at the USCG RDC.
The deadline for final responses to the RFI is 12 May 2017 . REMINDER: UNLESS RESPONSE IS GREATER THAN 10 MB, RESPONSES MUST BE EMAILED TO: RDC-SMB-MarineCoatingSys @uscg.mil

APPENDIX B. NCP 1K POLYSILOXANE INFORMATION SHEET

SILOXOSHIELD™

NCP Coatings and the Naval Research Laboratory developed single-component (1K) polysiloxane topcoat for U.S. Navy

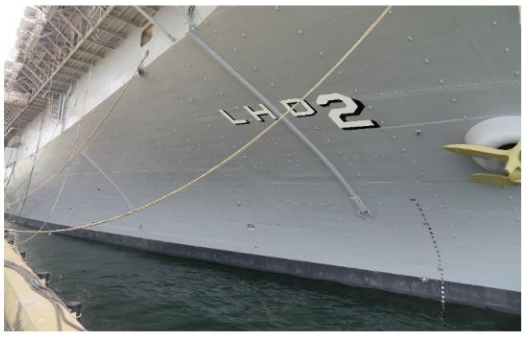


Roll application of SiloxoShield N-9999 1K by Ship's Force over a 3-year old 2K Polysiloxane on the freeboard of the USS ESSEX

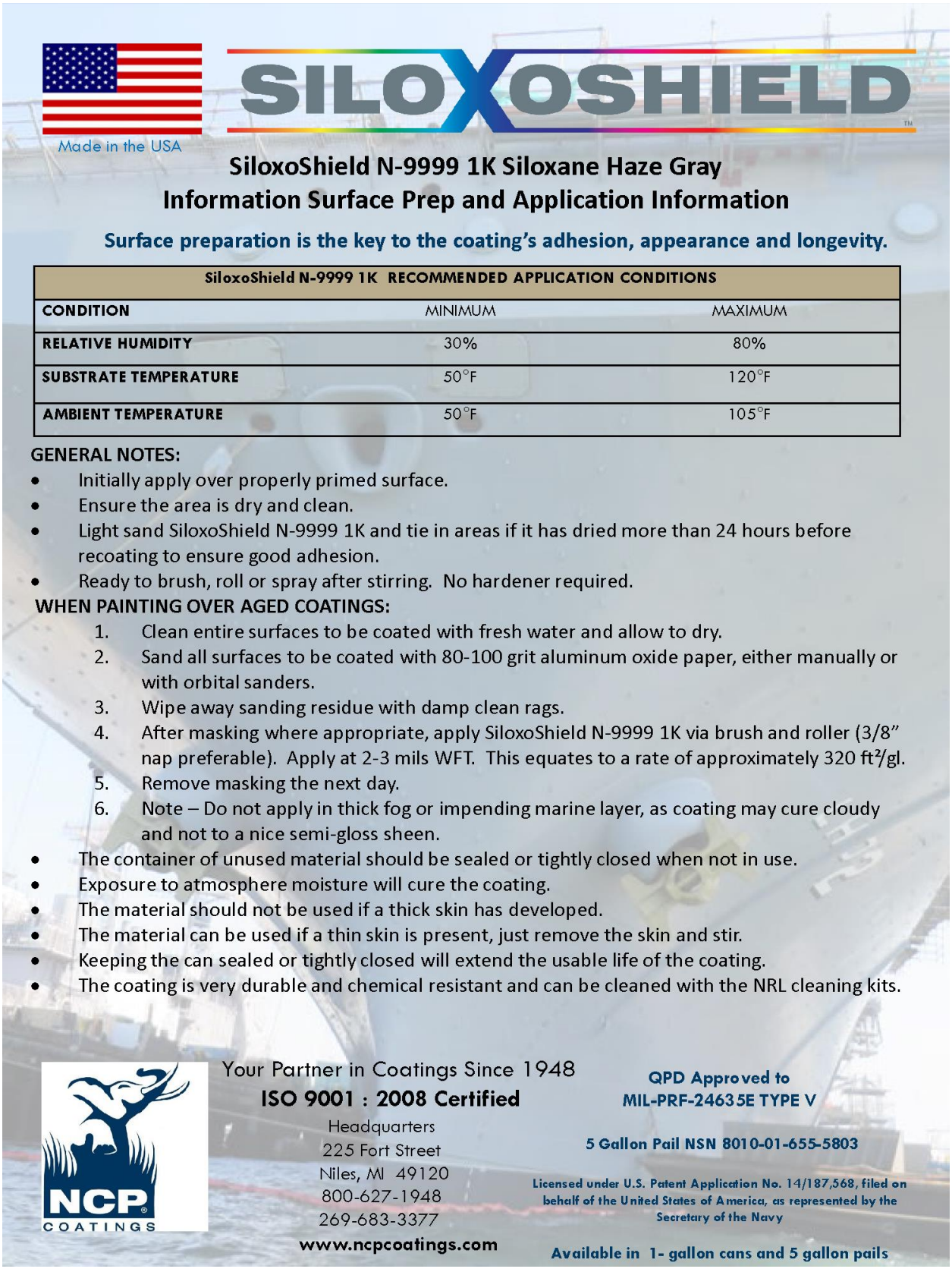
NCP Coatings – SiloxoShield N-9999 1K Siloxane Haze Gray

- A user-friendly paint – no mixing of multiple components before application
- Can be applied multiple times until the can is exhausted, minimizing HAZMAT
- Keeping the can sealed or tightly closed will extend the usable life of the coating.
- Can be applied by roll, brush or spray
- Adheres to epoxy primers and aged/prepared silicone alkyds/2K polysiloxane
- Environmentally friendly – isocyanate-free, HAPS-Free, and low in VOCs
- Uses the new Naval Research Lab LSA pigment package for enhanced color
- Out-performs qualified silicone alkyds and 2K polysiloxanes with regard to color stability
- Qualified to MIL-PRF-24635E, Type V requirements
- Demonstrated on multiple active Navy surface ships, including the entire freeboard of the USS ESSEX

Partially finished roll and brush application of N-9999 1K by Ship's Force on the USS ESSEX



Finished roll application of N-9999 1K by Ship's Force on the USS ESSEX



Made in the USA

SILOXOSHIELD™

SiloxoShield N-9999 1K Siloxane Haze Gray
Information Surface Prep and Application Information

Surface preparation is the key to the coating's adhesion, appearance and longevity.

SiloxoShield N-9999 1K RECOMMENDED APPLICATION CONDITIONS		
CONDITION	MINIMUM	MAXIMUM
RELATIVE HUMIDITY	30%	80%
SUBSTRATE TEMPERATURE	50°F	120°F
AMBIENT TEMPERATURE	50°F	105°F

GENERAL NOTES:

- Initially apply over properly primed surface.
- Ensure the area is dry and clean.
- Light sand SiloxoShield N-9999 1K and tie in areas if it has dried more than 24 hours before recoating to ensure good adhesion.
- Ready to brush, roll or spray after stirring. No hardener required.

WHEN PAINTING OVER AGED COATINGS:

1. Clean entire surfaces to be coated with fresh water and allow to dry.
2. Sand all surfaces to be coated with 80-100 grit aluminum oxide paper, either manually or with orbital sanders.
3. Wipe away sanding residue with damp clean rags.
4. After masking where appropriate, apply SiloxoShield N-9999 1K via brush and roller (3/8" nap preferable). Apply at 2-3 mils WFT. This equates to a rate of approximately 320 ft^2/gl.
5. Remove masking the next day.
6. Note – Do not apply in thick fog or impending marine layer, as coating may cure cloudy and not to a nice semi-gloss sheen.

- The container of unused material should be sealed or tightly closed when not in use.
- Exposure to atmosphere moisture will cure the coating.
- The material should not be used if a thick skin has developed.
- The material can be used if a thin skin is present, just remove the skin and stir.
- Keeping the can sealed or tightly closed will extend the usable life of the coating.
- The coating is very durable and chemical resistant and can be cleaned with the NRL cleaning kits.

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5 Gallon Pail NSN 8010-01-655-5803

Licensed under U.S. Patent Application No. 14/187,568, filed on behalf of the United States of America, as represented by the Secretary of the Navy

Available in 1- gallon cans and 5 gallon pails

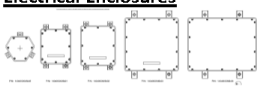
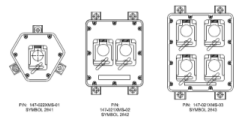
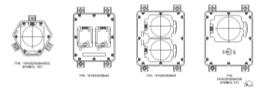
APPENDIX C. COMPOSITE COMPONENTS

Capital Investment for Labor (CIL-17) Composite Technology Fleet Summary — POC: Dr. Maureen Foley (maureen.foley@navy.mil)

Technology	NAVSEA DWG	Vendor	CAGE	P/N	NSN	Comments	Material
Composite Weather Deck Grating							
• I-Bar (pultruded)  ○ M-Clip (accessory) 	803-6983499A	Fibergrate	1T7T0	352702.2 352706.2 863527060.202	2540-01-654-4472 2040-01-660-9865 2540-01-654-4473	1.0 X 36.0 X 240.0 1.0 X 48.0 X 144.0 1.0 X 48.0 X 72.0	Glass Fiber/Phenolic
		Strongwell	1LL51	6747 6748 6749	2540-01-654-4472 2040-01-660-9865 2540-01-654-4473	1.0 X 36.0 X 240.0 1.0 X 48.0 X 144.0 1.0 X 48.0 X 72.0	Glass Fiber/Phenolic
		Strongwell	1LL51	6704	5340-01-529-4180	Grade A Shock qualified clip	CRES 316
		Commercial	-	NASM17830	5310-01-506-3673	5/16-18UNC Hexagonal Self Locking Nut	CRES 316
• Square (molded)  ○ M-Clip (accessory) 	-	Fibergrate	1T7T0	263451	-	1.5 x 1.5x 1.5 squares, 48" W x 96" L DDG 51 class BIW new construction reference	Glass Fiber/FR Vinyl Ester
	-			734250	5340-01-502-8426	Hold Down Clip Only	CRES 316
				710200	-	Clip, 2-1/4" long 1/4" diameter bolt, nut and washer	CRES 316
Vent Screen (molded)  ○ M-Clip (accessory) 	803-6983500	Fibergrate	1T7T0	269479	5670-01-529-4266	0.5" thick, 1.5" square mesh Panel size (4'x8')	Glass Fiber/MODAR
	803-6983500	Fibergrate	1T7T0	734250	5340-01-502-8426	Hold Down Clip Only	CRES 316

3/1/2018

Capital Investment for Labor (CIL-17) Composite Technology Fleet Summary POC: Dr. Maureen Foley (maureen.foley@navy.mil)

Technology	Type of Box	Glenair P/N	NSN	Symbol # MIL-HDBK-290	Replacement Parts	
					Cover NSN	Flop Lid NSN
Electrical Enclosures	**Junction**					
	Small Round Enclosure	140-060XMS-05	5975-01-556-7948	-	5940-01-557-2622	-
	Small Enclosure	140-060XMS-01	5975-01-556-7957	-	5940-01-557-2612	-
	Medium Enclosure	140-060XMS-02	5975-01-557-2672	-	5940-01-557-2616	-
	Large Enclosure	140-060XMS-03	5975-01-557-2679	-	5940-01-557-2626	-
	Extra Large Enclosure	140-060XMS-06	5975-01-658-2999	-	Glenair P/N avail	-
	**Sound Powered Telephone**					
	Single Jackbox	147-022XMS-01	5935-01-572-5487	2841	5935-01-572-5485	5975-01-556-9582
	Double Jackbox	147-021XMS-02	5935-01-572-6657	2842	5940-01-572-5480	5975-01-556-9582
	Four-Gang Jackbox	147-021XMS-03	5935-01-572-5631	2843	5940-01-572-5483	5975-01-556-9582
	**Electrical Receptacle**					
	Single Receptacle (15A, 125V Blade)	147-023XMS-01	5940-01-557-2645	-	5940-01-557-2585	5940-01-556-9621
	Single Receptacle (15A, 125V Blade w/threaded collar)	147-023XMS-02	5940-01-557-2667	1099.1	Glenair P/N avail	5940-01-556-9627
	Single Receptacle (15A, 125V 2-pole grounded)	147-023XMS-03	-	735.3	Glenair P/N avail	5940-01-556-9627
	Single Receptacle (15A, 125V MS3402)	147-033XMS-0003	5940-01-557-2725	1098.1	5940-01-557-2585	5940-01-556-9627
	Single Receptacle (15A, 125V, 400 Hz Blade w/threaded collar)	147-032XMS-0005G	5940-01-557-2719	1101	Glenair P/N avail	5940-01-556-9627
	Dual Receptacle (15A, 125V Blade)	147-020XMS-02	5940-01-556-9504	-	5975-01-556-9522	5940-01-556-9621
	Dual Receptacle (15A, 125V Blade w/threaded collars)	147-020XMS-05	5940-01-557-2634	-	5940-01-557-2587	5940-01-556-9627
	Single Receptacle with switch (15A, 125V Blade w/threaded collar)	147-038XMS-0008	6110-01-658-1317	919	-	5940-01-556-9627
	**Junction Box with Terminals**					
	Small Round Enclosure (six terminal, A-A-59125/12, 6TB6)	140-060XMS-05T2	5940-01-557-2579	520.1	5940-01-557-2622	-
	Small Round Enclosure (six terminal, A-A-59125/15, 9TB)	140-060XMS-05T4	5940-01-557-2712	-	5940-01-557-2622	-
	Small Round Enclosure (four terminal, A-A-59125/18, 13TB4)	140-060XMS-05T5	-	400.2	5940-01-557-2622	-
	Small Enclosure (eight terminal, A-A-59125/10, 4TB8)	140-060XMS-01T3	5940-01-556-7967	435.1	5940-01-557-2612	-
	Small Enclosure (ten terminal, A-A-59125/12, 6TB10)	140-060XMS-01T4	5940-01-556-9434	528	5940-01-557-2612	-
	Small Enclosure (four terminal, A-A-59125/20, 16TB4)	140-060XMS-01T6	5940-01-556-9443	444	5940-01-557-2612	-
	Large Enclosure (twenty terminal, A-A-59125/10, 4TB20)	140-060XMS-03T1	5940-01-556-9489	432.1	5940-01-557-2626	-
	Large Enclosure (thirty terminal, A-A-59125/12, 6TB6/6TB24)	140-060XMS-03T2	5940-01-557-2564	434	5940-01-557-2626	-
	Large Enclosure (ten terminal, A-A-59125/20, 16TB10)	140-060XMS-03T5	5940-01-557-2578	529	5940-01-557-2626	-
	Large Enclosure (forty terminal, A-A-59125/10, 4TB20)	140-060XMS-03T9	5940-01-557-2582	433.1	5940-01-557-2626	-
	Large Enclosure (forty eight terminal, A-A-59125/12, 6TB24)	140-060XMS-03T10	5940-01-556-9494	522.1	5940-01-557-2626	-
	Large Enclosure (sixty terminal, A-A-59125/10, 4TB20)	140-060XMS-03T11	5940-01-557-2563	446	5940-01-557-2626	-
	Large Enclosure (seventy two terminal, A-A-59125/12, 6TB24)	140-060XMS-03T12	5940-01-556-9499	525	5940-01-557-2626	-
	Extra Large Enclosure (forty eight terminal, A-A-59125/12, 6TB24) *	140-060XMS-06T1	-	522.1	Glenair P/N avail	-
	Extra Large Enclosure (sixty terminal, A-A-59125/10, 4TB20)*	140-060XMS-06T2	-	446	Glenair P/N avail	-
	Extra Large Enclosure (seventy two terminal, A-A-59125/12, 6TB24)*	140-060XMS-06T3	-	525	Glenair P/N avail	-

Manufacturer: Glenair
CAGE Code: 06234
Material: Glass/Polyetherimide
NAVSEA DWG 803-6983506B

* Extra Space for Wires

3/1/2018

Capital Investment for Labor (CIL-17) Composite Technology Fleet Summary POC: Dr. Maureen Foley (maureen.foley@navy.mil)

Technology	Comments	NSN	BAE P/N	Material
Composite Deck Drain Insert				
 2inch Type A, B, D  2 inch Type C  2 inch Type D (2 and 4 inch seal)  2 inch Type A (2 and 4 inch seal) Vendor: BAE San Diego Ship Repair CAGE Code: 57701 NAVSEA DWG: 803-6983511 Form, Fit and Function Replacement for Deck Fittings per 803-1385789 Diameter notation refers to diameter of outlet pipe	1.5-inch diameter Type A & G (2-inch seal)	4510-01-578-1029	DD 15 A S 100	Glass/Polyetherimide
	1.5-inch diameter Type A & G (4-inch seal)	4510-01-578-1022	DD 15 A L 100	
	2.0-inch diameter Type A & G (2-inch seal)	4510-01-578-1143	DD 20 A S 100	
	2.0-inch diameter Type A & G (4-inch seal)	4510-01-578-0844	DD 20 A L 100	
	1.5-inch diameter Type B	4510-01-632-7573	DD 15 B 100	
	2.0-inch diameter Type B	4510-01-633-0924	DD 20 B 100	
	1.5-inch diameter Type D & H (2-inch seal)	4510-01-578-0834	DD 15 D S 100	
	1.5-inch diameter Type D & H (4-inch seal)	4510-01-593-9171	DD 15 D L 100	
	2.0-inch diameter Type D & H (2-inch seal)	4510-01-578-1209	DD 20 D S 100	
	2.0-inch diameter Type D & H (4-inch seal)	4510-01-578-1109	DD 20 D L 100	
	2.0-inch diameter Type C &F	4510-01-649-3042	DD 20 C 100	
	1.5-inch diameter valve assembly (replacement part)	-	DD 15 A 200	
	2.0-inch valve assembly (replacement part)	-	DD 20 A 200	
	Shoulder Bolts (replacement part)	5306-01-578-1008	DD 00 C C 020	CRES 316
	T-wrench for valved assemblies (also works with fittings from 803-1385789)	5120-00-030-2738	-	Steel, med, galvanize

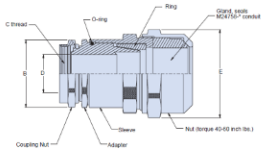
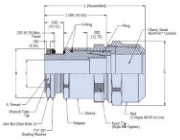
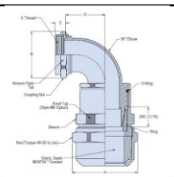
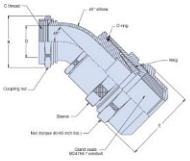
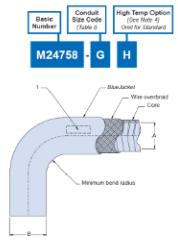
3/1/2018

Capital Investment for Labor (CIL-17) Composite Technology Fleet Summary POC: Dr. Maureen Foley (maureen.foley@navy.mil)

Technology	Specification	Vendor	CAGE	P/N	NSN	Comments	Material
Drain Trough Cover Plate							
	NSWCCD-65-TD-2015/35 NSWCCD-61-TD-2017/1	Currently NSWCCD for demonstration articles First Articles have been received by vendor for confirmation of quality	0FW37	NSWCCD-65/TD-2015/35-1 Bridge Wing Cover Plate – long, short, and small.	In Process	Approval for Use on DDG51 class ships in process	Glass/FR Vinyl Ester
Non EMI/EMP Heat Resistant Conduit and End Fittings							
 Before After LSD Well Deck Replaces braided ceramic sleeves	Commercial Item Description A-A-59827 Topside Conduit, (Flexible) and Conduit Fittings, Electrical: Composite Based (Non-Metallic)	Glenair	06234	120-108	N/A	Referred to in Section 630, Corrosion Control of General Specification for Overhaul (GSO)	Conduit Polyetheretherketone (PEEK) Fittings – Glass/Polyetherimide

3/1/2018

Capital Investment for Labor (CIL-17) Composite Technology Fleet Summary POC: Dr. Maureen Foley (maureen.foley@navy.mil)

Technology	P/N	NSN	Comments	Glenair Drawing
   Vendor: Glenair CAGE Code: 06234 Material: Glass/Polyetherimide EMI/EMP Conduit MIL-PRF-24758A (SH) PERFORMANCE SPECIFICATION CONDUIT SYSTEMS, FLEXIBLE, WEATHERPROOF	M24758-2BL	5975-01-657-4304	Electrical Adapter - Straight Conduit Size B	
	M24758-2CL	5975-01-657-4296	Electrical Adapter - Straight Conduit Size C	
	M24758-2DL	5975-01-657-4303	Electrical Adapter - Straight Conduit Size D	
	M24758-5BL	5975-01-657-4340	Electrical Adapter - Straight Conduit to Panel - Size B	
	M24758-5CL	5975-01-657-4335	Electrical Adapter - Straight Conduit to Panel - Size C	
	M24758-4BL	5975-01-657-4473	Electrical Adapter - 90 degree Conduit Size B	
	M24758-4CL	5975-01-657-4466	Electrical Adapter - 90 degree Conduit Size C	
	M24758-3BL	5975-01-657-4456	Electrical Adapter - 45 Degree Conduit Size B	
	M24758-3CL	5975-01-657-4452	Electrical Adapter - 45 Degree Conduit Size C	
	M24758-B	5975-01-584-5182	EMI/EMP Shielded Conduit Size B	
	M24758-C	LL-H0C-2617	EMI/EMP Shielded Conduit Size C	
	M24758-D	5975-01-643-3481	EMI/EMP Shielded Conduit Size D	

3/1/2018

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APPENDIX D. ACL-FLUDIZED BED WT DOORS

ACL TIDAL COAT

ACL's Proven track record is now brought to Watertight Doors

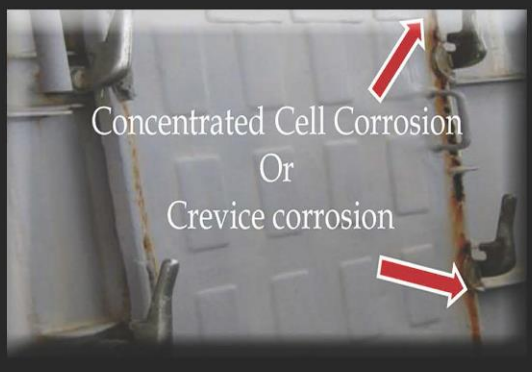
ACL has saved over 95 Million dollars in maintenance cost on Air Intake and Uptake Louvers

Dual Immersion Polymer Powder Process

An extremely durable fusion bonded multilayer process designedto encapsulate the component, uniformly covering inaccessible areas where all other coatings fail

Corrosion control without the cost of stainless steel door replacement

6 - year proven track record on Watertight Doors
18 - year track record on louvers



ACL's Patented process uniformly encapsulates and prevents crevice corrosion shown above

T 416-335-7500 F 416-335-7800 Toll Free 1-800-463-7500
211 Nugget Avenue, Toronto, ON M1S 3B1
www.automaticcoating.com

Watertight Doors

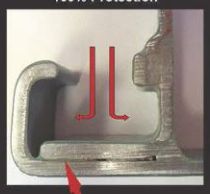
Fluid Bed Dip

High solids liquid over E-coat

Electrostatic powder over E-coat

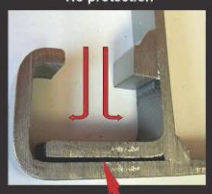
Cut away view

Encapsulated uniform coating 100% Protection



Coating sealed and penetrated crevice

Non-Uniform coating No protection

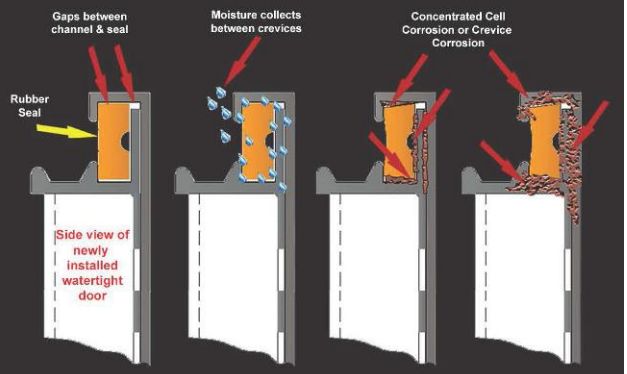


No sealing or penetration

Non-Uniform coating No protection

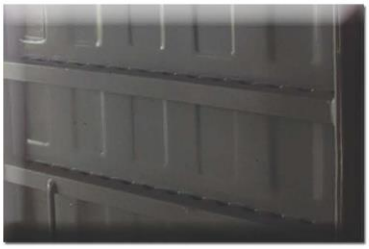
No sealing or penetration

Door Seal Assembly



Tidal Coat Processed Doors

Tidal Coat Processed Doors After 5 years



ISO 9001

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211 Nugget Avenue, Toronto, ON M1S 3B1
www.automaticcoating.com

APPENDIX E. SHERWIN WILLIAMS FAST CLAD ER

Protective & Marine Coatings

FAST CLAD® ER EPOXY
WITH OPTI-CHECK OAP TECHNOLOGY

PART A	B62W230	WHITE BASE
PART A	B62L230	BLUE OAP
PART A	B62RW230	RED OXIDE
PART B	B62V230	CLEAR HARDENER
PART B	B62AV230	GRAY HARDENER

Revised: October 28, 2014

PRODUCT INFORMATION

9.50

PRODUCT DESCRIPTION

Fast Clad ER Epoxy is an edge retentive, ultra high solids epoxy amine coating engineered for immersion service in sea water ballast tanks, fuel/sea water ballast tanks, and petroleum storage tanks. The rapid return to service and high build, edge retentive properties of this coating provide superior protection compared to conventional epoxies.

- One coat protection
- Fast return to service
- Low VOC
- Low odor
- Dry to walk-on within four hours
- Designed for plural-component application equipment
- Greater than 70% edge build retention
- Low Temperature application and cure capabilities to 35°F (See Application Conditions)

PRODUCT CHARACTERISTICS

Finish:	Gloss
Color:	White-Base, Blue OAP, Red Oxide
Volume Solids:	98%, ± 2%, mixed
Weight Solids:	98%, ± 2%, mixed
VOC (EPA method #24):	<85 g/L; 0.71 lb/gal, mixed
Mix Ratio:	1:1 by volume

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils (microns)	**18.0** (450)	**22.0** (550)
Dry mils (microns)	**18.0** (450)	**22.0** (550)
~Coverage sq ft/gal (m^2/L)	**73** (1.8)	**89** (2.2)

*Can be applied up to 60.0 mils (1500 microns) dft if required.

Theoretical coverage sq ft/gal (m^2/L) @ 1 mil / 25 microns dft **1568** (38.4)

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 20.0 mils (500 microns):

	@ 40°F/4.5°C	@ 77°F/25°C *50% RH*	@ 100°F/38°C
To touch:	6 hours	1 hour	35 minutes
To handle:	8-12 hours	3 hours	55 minutes
To recoat:			
minimum:	6 hours	1 hour	35 minutes
maximum:	14 days	14 days	14 days
Foot traffic:	8-12 hours	3 hours	1 hour
Cure to service:	36 hours	24 hours	12 hours
Pot Life:		7 minutes	
Sweat-in-Time:		None required	

Shelf Life:	24 months Store indoors at 40°F (4.5°C) to 100°F (38°C)
Flash Point:	230°F (110°C), PMCC, mixed
Reducer:	Not recommended
Clean Up:	MEK (R6K10) or Reducer R7K104

RECOMMENDED USES

For use over prepared steel or masonry surfaces in industrial and marine exposures such as:

- Ballast tank interiors and oil storage tank interiors
- Fuel storage tanks and external pipeline coating
- Primary or Secondary containment
- Acceptable for use with cathodic protection systems
- Where rapid return to service and edge protection film build properties are required
- Meets MIL-PRF-23236 Type VII, Class 5, 7, 5/18, 7/18, 13/18, 17, 17/18 Grade C requirements for single and multi-coat seawater, fuel, bilges, and CHT tanks
- Blue OAP contains fluorescent pigment
- Wind tower gearbox lining and transformer lining up to 204°F (96°C)
- Suitable for use in the Mining & Minerals Industry

PERFORMANCE CHARACTERISTICS

Substrate*: Steel

Surface Preparation*: SSPC-SP10

System Tested*:

1 ct. Fast Clad ER Epoxy @ 18.0-22.0 mils (450-550 microns) dft
*unless otherwise noted below

Test Name	Test Method	Results
Abrasion Resistance	ASTM D4060, CS17 wheel, 1000 cycles, 1 kg load	22.4 mg loss
Adhesion	ASTM D4541	>2000 psi
Cathodic Disbondment	ASTM G8	Passes 30 days @ 1.5 volts ($Cu/CuSO_4$), <10 mm disbondment radius
Corrosion Weathering	ASTM D5894, 4 cycles, 1134 hours	Rating 10 per ASTM D610 for Rusting (field); Rating 10 per ASTM D714 for Blistering (field)
Direct Impact Resistance	ASTM D2794	15 in-lb
Dry Heat Resistance	ASTM D2485	250°F (121°C)
Flexibility	ASTM D522	7/16" (24-hour cure)
Moisture Condensation Resistance	ASTM D4585, 100°F (38°C), 2000 hours	Rating 10 per ASTM D610 for Rusting (field); Rating 10 per ASTM D714 for Blistering (field)
Pencil Hardness	ASTM D3363	H

*Report No. IM54.1382-09

Immersion (ambient temperature) for the following:

- Ballast tank mix ..... Recommended
- Crude oil ..... Recommended
- Fresh water ..... Recommended
- Gasoline ..... Recommended
- Sea water..... Recommended
- Reformulated gasoline ..... Recommended
- Kerosene ..... Recommended

Epoxy coatings may darken or yellow after application and curing.

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continued on back

Protective & Marine Coatings

FAST CLAD® ER EPOXY
WITH OPTI-CHECK OAP TECHNOLOGY

Part A	B62W230	White Base
Part A	B62L230	Blue OAP
Part A	B62RW230	Red Oxide
Part B	B62V230	Clear Hardener
Part B	B62AV230	Gray Hardener

Revised: October 28, 2014

PRODUCT INFORMATION

9.50

RECOMMENDED SYSTEMS

		Dry Film Thickness / ct. Mils	(Microns)
Steel, immersion:			
1 ct.	Fast Clad ER Epoxy	18.0 -22.0	(450-550)
Steel, immersion:			
1 ct.	Fast Clad Epoxy Primer	4.0 -8.0**	(100-200)
1 ct.	Fast Clad ER Epoxy	18.0-22.0	(450-550)
Steel, immersion:			
2 cts.	Fast Clad ER Epoxy	9.0-11.0	(225-275)
Concrete, immersion:			
1 ct.	Corobond 100 Epoxy Primer/Sealer; apply primer to achieve uniform hiding, appearance, and complete wetting of the concrete surface, approximately 4-6 . Coating will be partially absorbed into the concrete. Roll out any pudles.		
2 cts.	Fast Clad ER Epoxy	9.0 – 11.0	(225-275)

**When using B62L245 Primer containing the OAP fluorescent pigment, make sure a non-containing OAP fluorescent pigment topcoat is used.

The systems listed above are representative of the product's use, other systems may be appropriate.

SAFETY PRECAUTIONS

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

DISCLAIMER

The information and recommendations set forth in this Product Data Sheet are based upon tests conducted by or on behalf of The Sherwin-Williams Company. Such information and recommendations set forth herein are subject to change and pertain to the product offered at the time of publication. Consult your Sherwin-Williams representative to obtain the most recent Product Data Information and Application Bulletin.

WARRANTY

The Sherwin-Williams Company warrants our products to be free of manufacturing defects in accord with applicable Sherwin-Williams quality control procedures. Liability for products proven defective, if any, is limited to replacement of the defective product or the refund of the purchase price paid for the defective product as determined by Sherwin-Williams. NO OTHER WARRANTY OR GUARANTEE OF ANY KIND IS MADE BY SHERWIN-WILLIAMS, EXPRESSED OR IMPLIED, STATUTORY, BY OPERATION OF LAW OR OTHERWISE, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

SURFACE PREPARATION

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Refer to product Application Bulletin for detailed surface preparation information.

Minimum recommended surface preparation:

Iron & Steel:

Atmospheric:	SSPC-SP6/NACE 3, 2 mil (50 micron) profile or SSPC-SP12/NACE No. 5, WJ-3/SC-2
Immersion:	SSPC-SP10/NACE2, 2-3 mil (50-75 micron) profile or SSPC- SP12/NACE No. 5, WJ-2/SC-2

Concrete & Masonry:

Atmospheric:	SSPC-SP13/NACE 6, or ICRI No. 310.2R, CSP2-3
Immersion:	SSPC-SP13/NACE 6-4.3.1 or 4.3.2, or ICRI No. 310.2R, CSP2-3

Surface Preparation Standards

Condition of Surface		ISO 8501-1 BS7079:A1	Swedish Std. SIS055900	SSPC	NACE
White Metal		Sa 3	Sa 3	SP 5	1
Near White Metal		Sa 2.5	Sa 2.5	SP 10	2
Commercial Blast		Sa 2	Sa 2	SP 6	3
Brush-Off Blast		Sa 1	Sa 1	SP 7	4
Hand Tool Cleaning	Rusted	C St 2	C St 2	SP 2	-
	Pitted & Rusted	D St 2	D St 2	SP 2	-
Power Tool Cleaning	Rusted	C St 3	C St 3	SP 3	-
	Pitted & Rusted	D St 3	D St 3	SP 3	-

TINTING

Do not tint part A. 5 gallons (18.9L) of clear hardener part B may be tinted with up to 2.75 ounces of Maxitoner Colorant Phthalo Green or Black only.

APPLICATION CONDITIONS

Temperature:

Air & surface:	40°F (4.5°C) minimum*, 110°F (43°C) maximum

*For application at 35°F (1.7°C) to 40°F (4.5°C), specific guidelines are required:

- Air & Surface temperature conditions must be expected to remain stable or improve for a period of four hours.
- Environmental controls (dehumidication, heating, forced-air ventilation) are recommended to maintain acceptable application conditions.
- Final cure must be confirmed in accordance with ASTM D5402, "Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs". Test shall consist of 50 double rubs with MEK. Test shall confirm no loss of DFT, and no coating residue on rubbing cloth.

The material should be 85°F-130°F/29°C-54°C (vary as needed) at the mixing block for optimal atomization based on tip size and pump pressure.. **Do not heat above 140°F/60°C.**

Relative humidity: 85% maximum

Refer to product Application Bulletin for detailed application information.

ORDERING INFORMATION

Packaging:

Part A:	5 gallon (18.9L) container
Part B:	5 gallon (18.9L) container

Weight: 11.71, ± 0.3 lb/gal ; 1.4 Kg/L, mixed

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Protective & Marine Coatings

FAST CLAD® ER EPOXY
WITH OPTI-CHECK OAP TECHNOLOGY

PART A	B62W230	WHITE BASE
PART A	B62L230	BLUE OAP
PART A	B62RW230	RED OXIDE
PART B	B62V230	CLEAR HARDENER
PART B	B62AV230	GRAY HARDENER

Revised: October 28, 2014

APPLICATION BULLETIN

9.50

SURFACE PREPARATIONS

Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion.

Iron & Steel (atmospheric service)
Minimum surface preparation is Commercial Blast Cleaning per SSPC-SP6/NACE 3 or SSPC-SP12/NACE No. 5. For surfaces prepared by SSPC SP6/NACE 3, first remove all oil and grease from surface by Solvent Cleaning per SSPC-SP1. For better performance, use Near White Metal Blast Cleaning per SSPC-SP10/NACE 2. Blast clean all surfaces using a sharp, angular abrasive for optimum surface profile (2-3 mils / 50-75 microns). For surfaces prepared by SSPC-SP12/NACE No. 5, all surfaces shall be cleaned in accordance with WJ-3/SC2. Pre-existing profile should be approximately 2 mils (50 microns). Prime any bare steel the same day as it is cleaned or before flash rusting occurs.

Iron & Steel (immersion service)
Remove all oil and grease from surface by Solvent Cleaning per SSPC-SP1. Minimum surface preparation is Near White Metal Blast Cleaning per SSPC-SP10/NACE 2, or SSPC-SP12/NACE No. 5. For SSPC-SP10/NACE 2, blast clean all surfaces using a sharp, angular abrasive for optimum surface profile (2-3 mils / 50-75 microns). For SSPC-SP12/NACE No.5, all surfaces to be coated shall be cleaned in accordance with WJ-2/SC2 standards. Pre-existing profile should be approximately 2 mils (50 microns). Remove all weld spatter. Prime any bare steel the same day as it is cleaned or before flash rusting occurs.

Concrete and Masonry
For surface preparation, refer to SSPC-SP13/NACE 6, or ICRI No. 310.2R, CSP 2-3. Surfaces should be thoroughly clean and dry. Concrete and mortar must be cured at least 28 days @ 75°F (24°C). Remove all loose mortar and foreign material. Surface must be free of laitance, concrete dust, dirt, form release agents, moisture curing membranes, loose cement and hardeners. Fill bug holes, air pockets and other voids with Steel-Seam FT910. Primer required.

Follow the standard methods listed below when applicable:
ASTM D4258 Standard Practice for Cleaning Concrete.
ASTM D4259 Standard Practice for Abrading Concrete.
ASTM D4260 Standard Practice for Etching Concrete.
ASTM F1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete.
SSPC-SP 13/Nace 6 Surface Preparation of Concrete.
ICRI No. 310.2R Concrete Surface Preparation.

Concrete, Immersion Service:
For surface preparation, refer to SSPC-SP13/NACE 6, Section 4.3.1 or 1.3.2 or ICRI No. 310.2R, CSP 2-3.

Surface Preparation Standards

	Condition of Surface	ISO 8501-1 BS7079:A1	Swedish Std. SIS055900	SSPC	NACE
White Metal		Sa 3	Sa 3	SP 5	1
Near White Metal		Sa 2.5	Sa 2.5	SP 10	2
Commercial Blast		Sa 2	Sa 2	SP 6	3
Brush-Off Blast		Sa 1	Sa 1	SP 7	4
Hand Tool Cleaning	Rusted	C St 2	C St 2	SP 2	-
	Pitted & Rusted	D St 2	D St 2	SP 2	-
Power Tool Cleaning	Rusted	C St 3	C St 3	SP 3	-
	Pitted & Rusted	D St 3	D St 3	SP 3	-

APPLICATION CONDITIONS

Temperature:
Air & surface: 40°F (4.5°C) minimum*, 110°F (43°C) maximum

*For application at 35°F (1.7°C) to 40°F (4.5°C), specific guidelines are required:

- Air & Surface temperature conditions must be expected to remain stable or improve for a period of four hours.
- Environmental controls (dehumidication, heating, forced-air ventilation) are recommended to maintain acceptable application conditions.
- Final cure must be confirmed in accordance with ASTM D5402, "Assessing the Solvent Resistance of Organic Coatings Using Solvent Rubs". Test shall consist of 50 double rubs with MEK. Test shall confirm no loss of DFT, and no coating residue on rubbing cloth.

The material should be 85°F-130°F/29°C-54°C (vary as needed) at the mixing block for optimal atomization based on tip size and pump pressure.. **Do not heat above 140°F/60°C.**

Relative humidity: 85% maximum

APPLICATION EQUIPMENT

The following is a guide. Changes in pressures and tip sizes may be needed for proper spray characteristics. Always purge spray equipment before use with listed reducer. Any reduction must be compliant with existing VOC regulations and compatible with the existing environmental and application conditions.

Reduction ..... Not recommended

Clean Up ..... MEK (R6K10) or R7K104

Plural Component Equipment
Pump..... WIWA DUOMIX 1:1, Graco Extreme Mix, Graco XM, or Graco XP
Pressure..... 4000 psi
Hose..... 3/8" ID
Tip..... .021" - .025"
Pump heater setting..... 70 - 80
Material temperature at gun tip..... 85°F-130°F (29°C-54°C) (vary as needed)

Brush ..... For stripe coating and repair only
Brush..... Nylon/Polyester or Natural Bristle

Roller ..... For stripe coating and repair only
Cover ..... 3/8" woven with solvent resistant core

If specific application equipment is not listed above, equivalent equipment may be substituted.

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Revised: October 28, 2014

APPLICATION BULLETIN

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APPLICATION PROCEDURES

Surface preparation must be completed as indicated.

Mixing Instructions: Mix contents of each component thoroughly using low speed power agitation. Make certain no pigment remains on the bottom or the sides of the can. Then combine one part by volume of Part A with one part by volume of Part B. Thoroughly agitate the mixture with power agitation.
To ensure that no unmixed material remains on the sides or bottom of the cans after mixing, visually observe the container by pouring the material into a separate container.

Apply paint at the recommended film thickness and spreading rate as indicated below:

Recommended Spreading Rate per coat:

	Minimum	Maximum
Wet mils (microns)	**18.0** (450)	**22.0** (550)
Dry mils (microns)	**18.0** (450)	**22.0** (550)
~Coverage sq ft/gal (m^2/L)	**73** (1.8)	**89** (2.2)

*Can be applied up to 60.0 mils (1500 microns) dft if required.

Theoretical coverage sq ft/gal (m^2/L) @ 1 mil / 25 microns dft **1568** (38.4)

NOTE: Brush or roll application may require multiple coats to achieve maximum film thickness and uniformity of appearance.

Drying Schedule @ 20.0 mils (500 microns):

	@ 40°F/4.5°C	@ 77°F/25°C *50% RH*	@ 100°F/38°C
To touch:	6 hours	1 hour	35 minutes
To handle:	8-12 hours	3 hours	55 minutes
To recoat:			
minimum:	6 hours	1 hour	35 minutes
maximum:	14 days	14 days	14 days
Foot traffic:	8-12 hours	3 hours	1 hour
Cure to service:	36 hours	24 hours	12 hours
Pot Life:		7 minutes	
Sweat-in-Time:		None required	

Application of coating above maximum or below minimum recommended spreading rate may adversely affect coating performance.

CLEAN UP INSTRUCTIONS

Clean spills and spatters immediately with MEK, R6K10. Clean tools immediately after use with MEK, R6K10. Follow manufacturer's safety recommendations when using any solvent.

DISCLAIMER

The information and recommendations set forth in this Product Data Sheet are based upon tests conducted by or on behalf of The Sherwin-Williams Company. Such information and recommendations set forth herein are subject to change and pertain to the product offered at the time of publication. Consult your Sherwin-Williams representative to obtain the most recent Product Data Information and Application Bulletin.

PERFORMANCE TIPS

Repair of Pitted Tank Bottoms
Extensive, deep pitting:
Options:
Option 1 ..Apply a full wet coat, by spray application, of Fast Clad Epoxy Primer. Follow with rubber squeegee to work material into and fill the pitted areas. After recommended drying time, apply a full coat of Fast Clad ER at recommended film thickness.
Option 2 ..Apply Dura-Plate UHS Clear Laminant Resin with 1½ oz fiberglass mat over the pitted areas. After recommended drying time, apply a full coat of Fast Clad ER at recommended film thickness.
Option 3 ..Weld new steel plates, or use puddle welds, as required to repair pitted areas. Coat areas as recommended.
Shallow pitting, isolated areas:
Options:
Option 1 ..Same as number 1 above.
Option 2 ..Apply Steel Seam FT910 as required to fill the pitted areas. Coat areas as recommended.

When using spray application, use a 50% overlap with each pass of the gun to avoid holidays, bare areas, and pinholes. If necessary, cross-coat spray at a right angle.

Spreading rates are calculated on volume solids and do not include an application loss factor due to surface profile, roughness or porosity of the surface, skill and technique of the applicator, method of application, various surface irregularities, material lost during mixing, spillage, overthinning, climatic conditions, and excessive film build.
No reduction of material is recommended as this can affect film build, appearance, and adhesion.

Stripe coat all crevices, welds, and sharp angles to prevent early failure in these areas.

Do not mix previously catalyzed material with new.

Do not apply the material beyond recommended pot life.

Remove and solvent clean tip housing every 20-30 minutes.

For Immersion Service: (if required) Holiday test in accordance with ASTM D5162 for steel, or ASTM D4787 for concrete.

When using an OAP fluorescent pigment system, use the Fast Clad Epoxy Primer, with a non-OAP containing Fast Clad ER topcoat color.

Guidance on techniques and required equipment to inspect a coating system incorporating Opti-Check OAP Technology can be found in SSPC-TU 11.

Refer to Product Information sheet for additional performance characteristics and properties.

SAFETY PRECAUTIONS

Refer to the MSDS sheet before use.

Published technical data and instructions are subject to change without notice. Contact your Sherwin-Williams representative for additional technical data and instructions.

WARRANTY

The Sherwin-Williams Company warrants our products to be free of manufacturing defects in accord with applicable Sherwin-Williams quality control procedures. Liability for products proven defective, if any, is limited to replacement of the defective product or the refund of the purchase price paid for the defective product as determined by Sherwin-Williams. NO OTHER WARRANTY OR GUARANTEE OF ANY KIND IS MADE BY SHERWIN-WILLIAMS, EXPRESSED OR IMPLIED, STATUTORY, BY OPERATION OF LAW OR OTHERWISE, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

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APPENDIX F. TERMARUST INFORMATION

Product Description

TERMARUST®PRIMER/TOPCOATSERIES TR2100 HRCSA (HIGH RATIO CO-POLYMERIZED CALCIUM SULFONATE)

Termarust High Ratio Co-Polymerized Calcium Sulfonate (HRCSA),"**Primer/Topcoat**" is a pigmented and non- pigmented coating designed and engineered exclusively for:

A) ENCAPSULATION (overcoat)

- Existing aged leaded paint
- Vinyl, coal tar epoxy, polyurethane, epoxy mastics, acrylics, organic or inorganic zinc
- Galvanizing metallizing
- Tightly adhered contaminant free rust

B) **RE-COATING of new or prepared structural steel. By sandblasting or Ultra-High Pressure (UHP) water jetting.**

The Termarust TR2100 High Ratio Co-Polymerized Calcium Sulfonate proprietary formulation has the unique ability to:

- Neutralize acidity
- Create a hydrophobic barrier
- Bonds ionically and thoroughly wets the surface profile making it ideal for the reclamation and long term protection of:
  - bridges
  - steel structures
  - cable suspension systems
  - industrial infrastructures
  - highway overpasses
  - utility towers
  - pipelines

Termarust TR2100 High Ratio Co-Polymerized Calcium Sulfonate is an outstanding, easy to use, maintenance coating where long-term spot repairs are required.

NOTE: The Termarust® TR2100 HRCSA Primer/Topcoat**is not intended** for application on metal surfaces in specific areas exposed to friction and abrasion from pedestrian circulation or rolling equipment. (ex.: running rails, pedestrian crosswalks, handrails, access ramps, ladders, etc.).

Termarust manufactures the only HRCSA coatings with a 24 year field history of solving structure critical corrosion on structural steel.

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APPENDIX G. ECOSPEED

ECOSPEED®
SHIP HULL PERFORMANCE TECHNOLOGY

APPLICATION GUIDE ECOSPEED® FOR STEEL SURFACES

October 2012
Revision of July 2010

STORAGE

Very important: maximum storage temperature of Ecospeed® is 68 °F.

PREPARATION

This procedure supplements recognised near-white metal grit blasting standards to provide control of surface profile, surface cleanliness and environment.

Oil and grease shall be removed by solvent cleaning prior to grit blasting. Use dry wiping and scraping to remove heavy deposits of oil and grease followed by localised wiping with clean rags dampened with solvent. Avoid spread of contaminants. Sharp edges, fillets, corners and welds shall be rounded or smoothened by grinding (minimum radius of 2 mm).

The surface shall be grit blasted to minimum Sa 2½ standard. The surface profile shall be minimum 3 mils (Rz).

The particle size of all abrasives used for blast cleaning shall be capable of producing the above surface profile. Blast products and debris shall be removed from the surface of blast-cleaned steel by high-pressure air and/or vacuum cleaning. Compressed air used for blasting shall be clean, dry, and free from oil and water.

Separators shall be placed as close as possible to the blast cleaning equipment. Removal of contaminants such as oil, grease, handprints and other foreign matter from blast cleaned steel by solvent. Re-blasting to specification shall follow cleaning. An inhibitive treatment shall not be applied to blast cleaned steel.

MATERIAL MIXING

Ecospeed® is a two-component coating. The quantity of catalyst used can be varied to suit the ambient temperature, and rate of cure desired. The range is from 1% to 2% for spray application. The ambient temperature will govern the pot life of the material and batch size should be determined accordingly.

Ecospeed is a registered brand name of Subsea Industries NV
Haven 29, Noorderlaan 9, 2030 Antwerp, Belgium
☎: +32 3 213 53 18 🖷: +32 3 213 53 21
info@ecospeed.be - www.ecospeed.be

Mixing should be by powered equipment such as a drill motor with an appropriate whip. Carefully measure the required amount of material into the mixing container, measure the required amount of catalyst and add to the material. Mix thoroughly to ensure full dispersal of catalyst, and any thinner if required. Mix for approximately 3 minutes.

REQUIRED AMOUNT

Catalyst (Butanox LPT)

T ambient	Mixing ratio	For 20 liter*	For 1 liter**	Overcoat time
< 77 °F	2 %	400 ml (0.1 gallon)	20 ml	Minimum 3 hours
> 77 °F	1 %	200 ml(0.05 gallon)	10 ml	Minimum 3 hours

* 5.28 US gallon - **0.26 US gallon

Thinner (Styrene) – if required

Mixing ratio	For 20 litre	For 1 litre	Overcoat time
2.5 %	500 ml (0.13 gallon)	25 ml	Minimum 3 hours

CLEANING

Recommended cleaning solvent for the pump installation is Acetone.

APPLICATION

First coat
Using spray equipment to apply one full coat of catalysed material to a DFT thickness of 20 mils (WFT thickness of 25 mils). Allow to cure. The second coat can be applied as soon as the first coat is cured, approximately 3 hours at a temperature of 68 °F.

Second coat
Using spray equipment to apply the second full coat of catalysed material to a DFT of 20 mils (25 mils wet). The total DFT shall be minimum 40 mils.

A long soft bristle brush may be allowed to apply Ecospeed® on small areas and to perform repairs. An approval from Subsea Industries is necessary prior to any brush application.

On inspector's request welds and corners may be stripe-coated with one coat of Ecospeed® in between the first and second coats. For brush application please refer to the notes at the end of this procedure.

SPRAY EQUIPMENT

Airless Spray Pump 63:1 or higher is recommended. Spare packing should be available on all large contracts.

There should be no filters or strainers in the pump unit, the fluid lines or the gun, nor should there be diffusers in the tip. No foot extension should be used on the pump. This is all to promote the free flow of the material and to prevent packing of the glass platelets, which can cause blockages leading to premature curing in the body of the spray pump.

NOTE: if there is no pressure release valve in the system, caution should be exercised when removing lines/guns. Bleed off the remaining pressure carefully.

The fluid hose should be 3/8" internal diameter and the shortest length suitable for practical application to promote free flow of the material and minimise pressure loss. No restrictive couplings should be used on the fluid hose; the gun should be hooked up directly to the line. A swivel hook-up is a must and will give easy manoeuvrability of the gun when spraying.

An airless spray gun of 500 bar (high volume) without diffuser is recommended. This should be used in conjunction with a 'Reverse-A-Quick' head with a 631 tip, again with no strainers or diffusers.

SPRAY PROCEDURE

Ecospeed® cures by chemical reaction, which starts as soon as catalyst is added and then proceeds quite quickly. When spraying use the minimum amount of catalyst permissible i.e. 1% by volume.

If the correct equipment is used, Ecospeed® can be applied at high application rates. It is a simple material to apply if the recommended procedure is followed.

Perform a test spray procedure prior to the actual application, using no catalyst.

1. Assemble full equipment and flush through with solvent.
2. Remove the gun and circulate material through lines.
3. Attach gun and check that the spray pattern is satisfactory by adjusting the pressure.
4. Remove gun from the line, and the pump from the material.
5. Mix material as detailed above and replace the pump.
6. Circulate material back into the mix container until all un-catalysed material has been removed from the lines.
7. Re-attach gun and trigger and remove solvent from gun and line.
8. The equipment is now ready for use.

NOTE: Do not add Acetone solvent to material.

REMEMBER

- Avoid airlocks by ensuring that the fluid leg is always immersed.
- As always extreme care should be taken to avoid contamination of the material and the working equipment to minimize the possibility of foreign matter entering the system and causing blockages.

This will ensure a continuous flow of the material and reduce the possibility of premature curing in the equipment.

- The material should be sprayed at distance of approximately 2 feet from the surface. Passes should be made keeping the gun at an even distance from the surface. At least 2 small passes will be required to attain the specified thickness. Successive passes should be at right angles to previous pass.

CLEANING

1. First cut off the air pressure at the pump and bleed carefully to release the pressure on the fluid line and gun. Remove the Reverse-A-Quick head from the gun and clean with solvent.
2. Flush out the pump, line and gun with solvent and allow this to circulate for 5 minutes at least.
3. To recommence spraying, purge line and gun with material before replacing tip.
4. It is recommended to flush pump and lines by the above procedure every 30 minutes.
5. When spraying is complete or before down time, it is essential to clean the equipment thoroughly by the above procedure but allow solvent to circulate for 20 minutes, finally flushing with clean Acetone.

NOTE: Do not leave catalysed material standing in the pump, line or gun.

If these procedures are followed clogging or packing should not occur. Should blockages arise, these must be dealt with swiftly by progressively cleaning the tip, gun, line and pump as indicated in the cleaning procedure. If delays occur for any reason when the material is mixed and spraying has commenced, care must be taken not to exceed the pot life or the material. If there is any danger of this happening or the pump shows signs of labouring the pump unit, fluid lines and guns should be flushed out with solvent as described above. Depending on the length of time of the delay it may be necessary for a fresh drum of material to be mixed (after flushing) before continuing the operation.

QUALITY CONTROL

Ecospeed® should not be applied when humidity is above 85%.
Ecospeed® should not be applied when the temperature of the steel at the coldest point is less than 5 °F above the dew point.
Ecospeed® should not be applied when the temperature of the steel surface is 140 °F or higher.
Ecospeed® should not be applied when the surface temperature of the material to be coated is less than 32 °F.

During application, spot-check thickness with a wet film gauge for both coats.

After a minimum 12 hours cure, thickness DFT readings should be taken using an Elcometer gauge or similar. Final thickness should be 40 mils DFT after application of the two layers.

Defect repair: Areas with less than the required DFT should re-coated following the general principles as explained above. Ecospeed® damaged after application should be repaired following our repair guide (available on request).

WATER IMMERSION

Note that the minimum curing time of Ecospeed® before immersion in water is 24 hours after application of the final coat.

NOTES

Airless spraying is the preferred method of application. When sprayed on at the correct thickness Ecospeed® will "flow" to form a smooth surface with a slight orange peel effect but when applied too thinly it will have a rough finish because the coating will be present as small blobs, which are not thick enough to join up and flow together.

When applying by brush it is difficult to achieve 20 mils per coat and you may need 3 or possibly 4 coats to get the correct thickness. Ecospeed® will not flow and give a nice finish unless at least 10 to 12 mils are applied per coat. The brush should be used to "lay" the material onto the surface, holding it at an angle of 45 to 60° from the vertical. This will ensure that the best possible thickness is applied.

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APPENDIX H. ECOSHIELD

ECOSHIELD®
THE DIAMOND STANDARD IN STEEL PROTECTION

APPLICATION GUIDE ECOSHIELD® FOR STEEL SURFACES

June 2015
Revision of October 2013

STORAGE

Very important: maximum storage temperature of Ecoshield® is 68 ºF.

PREPARATION

This procedure supplements recognised near-white metal grit blasting standards to provide control of surface profile, surface cleanliness and environment.

Oil and grease shall be removed by solvent cleaning prior to grit blasting. Use dry wiping and scraping to remove heavy deposits of oil and grease followed by localised wiping with clean rags dampened with solvent. Avoid spread of contaminants. Sharp edges, fillets, corners and welds shall be rounded or smoothened by grinding (minimum radius of 2 mm).

The surface shall be grit blasted to minimum Sa 2½ standard (SSPC-SP 10 or NACE No. 2). The surface profile shall be minimum 3 mills (Rz).

The particle size of all abrasives used for blast cleaning shall be capable of producing the above surface profile. Blast products and debris shall be removed from the surface of blast-cleaned steel by high-pressure air and/or vacuum cleaning. Compressed air used for blasting shall be clean, dry, and free from oil and water.

Separators shall be placed as close as possible to the blast cleaning equipment. Removal of contaminants such as oil, grease, handprints and other foreign matter from blast cleaned steel by solvent. Re-blasting to specification shall follow cleaning. An inhibitive treatment shall not be applied to blast cleaned steel.

MATERIAL MIXING

Ecoshield® is a two-component coating. The quantity of catalyst used can be varied to suit the ambient temperature, and rate of cure desired. The range is from 1% to 2% for spray application. The ambient temperature will govern the pot life of the material and batch size should be determined accordingly.

Mixing should be by powered equipment such as a drill motor with an appropriate whip. Carefully measure the required amount of material into the mixing container, measure the required amount of catalyst and add to the material. Mix thoroughly to ensure full dispersal of catalyst, and any thinner if required. Mix for approximately 3 minutes.

REQUIRED AMOUNT

Catalyst (Butanox LPT-IN)

T ambient	Mixing ratio	For 20 liter*	For 1 liter**	Overcoat time
< 77 °F	2 %	400 ml (0.1 gallon)	20 ml	Minimum 3 hours
> 77 °F	1 %	200 ml(0.05 gallon)	10 ml	Minimum 3 hours

* 5.28 US gallon - **0.26 US gallon

Thinner (Styrene) – if required

Mixing ratio	For 20 litre	For 1 litre	Overcoat time
2.5 %	500 ml (0.13 gallon)	25 ml	Minimum 3 hours

CLEANING

Recommended cleaning solvent for the pump installation is Acetone.

APPLICATION

First coat
Using spray equipment to apply one full coat of catalysed material to a DFT thickness of 20 mils (WFT thickness of 25 mils). Allow to cure. The second coat can be applied as soon as the first coat is cured, approximately 3 hours at a temperature of 68 °F.

Second coat
Using spray equipment to apply the second full coat of catalysed material to a DFT of 20 mils (25 mils wet). The total DFT shall be minimum 40 mils.

A long soft bristle brush may be allowed to apply Ecoshield® on small areas and to perform repairs. An approval from Subsea Industries is necessary prior to any brush application.

On inspector's request welds and corners may be stripe-coated with one coat of Ecoshield® in between the first and second coats. For brush application please refer to the notes at the end of this procedure.

SPRAY EQUIPMENT

Airless Spray Pump 63:1 or higher is recommended. Spare packing should be available on all large contracts.

There should be no filters or strainers in the pump unit, the fluid lines or the gun, nor should there be diffusers in the tip. No foot extension should be used on the pump.

This is all to promote the free flow of the material and to prevent packing of the glass platelets, which can cause blockages leading to premature curing in the body of the spray pump.

NOTE: if there is no pressure release valve in the system, caution should be exercised when removing lines/guns. Bleed off the remaining pressure carefully.

The fluid hose should be 3/8" internal diameter and the shortest length suitable for practical application to promote free flow of the material and minimise pressure loss. No restrictive couplings should be used on the fluid hose; the gun should be hooked up directly to the line. A swivel hook-up is a must and will give easy manoeuvrability of the gun when spraying.

An airless spray gun of 500 bar (high volume) without diffuser is recommended. This should be used in conjunction with a 'Reverse-A-Quick' head with a 631 tip, again with no strainers or diffusers.

SPRAY PROCEDURE

Ecoshield® cures by chemical reaction, which starts as soon as catalyst is added and then proceeds quite quickly. When spraying use the minimum amount of catalyst permissible i.e. 1% by volume.

If the correct equipment is used, Ecoshield® can be applied at high application rates. It is a simple material to apply if the recommended procedure is followed.

Perform a test spray procedure prior to the actual application, using no catalyst.

1. Assemble full equipment and flush through with solvent.
2. Remove the gun and circulate material through lines.
3. Attach gun and check that the spray pattern is satisfactory by adjusting the pressure.
4. Remove gun from the line, and the pump from the material.
5. Mix material as detailed above and replace the pump.
6. Circulate material back into the mix container until all un-catalysed material has been removed from the lines.
7. Re-attach gun and trigger and remove solvent from gun and line.
8. The equipment is now ready for use.

NOTE: Do not add Acetone solvent to material.

REMEMBER

- Avoid airlocks by ensuring that the fluid leg is always immersed.
- As always extreme care should be taken to avoid contamination of the material and the working equipment to minimize the possibility of foreign matter entering the system and causing blockages.
  This will ensure a continuous flow of the material and reduce the possibility of premature curing in the equipment.
- The material should be sprayed at distance of approximately 2 feet from the surface. Passes should be made keeping the gun at an even distance from the surface. At least 2 small passes will be required to attain the specified thickness. Successive passes should be at right angles to previous pass.

CLEANING

1. First cut off the air pressure at the pump and bleed carefully to release the pressure on the fluid line and gun. Remove the Reverse-A-Quick head from the gun and clean with solvent.
2. Flush out the pump, line and gun with solvent and allow this to circulate for 5 minutes at least.
3. To recommence spraying, purge line and gun with material before replacing tip.
4. It is recommended to flush pump and lines by the above procedure every 30 minutes.
5. When spraying is complete or before down time, it is essential to clean the equipment thoroughly by the above procedure but allow solvent to circulate for 20 minutes, finally flushing with clean Acetone.

NOTE: Do not leave catalysed material standing in the pump, line or gun.

If these procedures are followed clogging or packing should not occur. Should blockages arise, these must be dealt with swiftly by progressively cleaning the tip, gun, line and pump as indicated in the cleaning procedure. If delays occur for any reason when the material is mixed and spraying has commenced, care must be taken not to exceed the pot life or the material. If there is any danger of this happening or the pump shows signs of labouring the pump unit, fluid lines and guns should be flushed out with solvent as described above. Depending on the length of time of the delay it may be necessary for a fresh drum of material to be mixed (after flushing) before continuing the operation.

ECOSHIELD®
THE DIAMOND STANDARD IN STEEL PROTECTION

QUALITY CONTROL

Ecospeed® should not be applied when humidity is above 85%.
Ecospeed® should not be applied when the temperature of the steel at the coldest point is less than 5 °F above the dew point.
Ecospeed® should not be applied when the temperature of the steel surface is 140 °F or higher.
Ecospeed® should not be applied when the surface temperature of the material to be coated is less than 32 °F.

During application, spot-check thickness with a wet film gauge for both coats.

After a minimum 12 hours cure, thickness DFT readings should be taken using an Elcometer gauge or similar. Final thickness should be 40 mils DFT after application of the two layers.

Defect repair: Areas with less than the required DFT should re-coated following the general principles as explained above. Ecoshield® damaged after application should be repaired following our repair guide (available on request).

WATER IMMERSION

Note that the minimum curing time of Ecoshield® before immersion in water is 24 hours after application of the final coat.

NOTES

Airless spraying is the preferred method of application. When sprayed on at the correct thickness Ecoshield® will "flow" to form a smooth surface with a slight orange peel effect but when applied too thinly it will have a rough finish because the coating will be present as small blobs, which are not thick enough to join up and flow together.

When applying by brush it is difficult to achieve 20 mils per coat and you may need 3 or possibly 4 coats to get the correct thickness. Ecospeed® will not flow and give a nice finish unless at least 10 to 12 mils are applied per coat. The brush should be used to "lay" the material onto the surface, holding it at an angle of 45 to 60° from the vertical. This will ensure that the best possible thickness is applied.

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ECOSHIELD®
THE DIAMOND STANDARD IN STEEL PROTECTION

LIMITATION OF LIABILITY

The information in the data sheet is based upon laboratory tests we believe to be accurate and is intended for guidance only. All recommendations or suggestions relating to the use of the Subsea Industries products, whether in technical documentation, or in response to a specific enquiry, or otherwise, are based on data which to the best of our knowledge are reliable. The products and information are designed for users having the requisite knowledge and industrial skills and it is the end-user's responsibility to determine the suitability of the product for its intended use.

Subsea Industries has no control over either the quality or condition of the substrate, or many factors affecting the use and application of the product. Subsea Industries does therefore not accept any liability arising from loss, injury or damage resulting from such use or the contents of this data sheet (unless there are written agreements stating otherwise).

The data contained herein are liable to modification as a result of practical experience and continuous product development.

This data sheet replaces and annuls all previous issues and it is therefore the user's responsibility to ensure that this sheet is current prior to using the product.
The English text of this document shall prevail over any translation thereo

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