

15-Year Inspections Reveals the Effectiveness of Single-Coat Epoxy Coating System

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ABSTRACT

In 2000, the US Naval Research Laboratory (NRL) for Corrosion Science & Engineering began work on the Future Naval Capabilities' Single Coat Program. The program aimed to reduce corrosion damage and maintenance time by replacing legacy, solvent-based coatings with high solids, single coat, rapid cure, MIL-PRF-23236D Type VII high solids epoxy coatings to the fleet.

In 2005, a US Navy ship's seawater ballast tank coating had failed and needed replacement. The failed coating (applied in 1996) was replaced by a 100% solids epoxy coating system and the ship was returned to service. Follow-up inspections on the coating's performance were conducted 15 months, 7.5 years, and 15.5 years after the lining was applied.

The 100% solids, single coat epoxy coatings system demonstrated that it was meeting the Navy's goals of minimizing failures and reducing maintenance costs.

Key words: asset protection, ballast tanks, ballast tank coatings, coating protection, coatings, cost savings, epoxy, epoxy solutions, extended service-life, maritime, Naval ships, one coat application, rapid return to service, reduced maintenance time, ships, single coat epoxy, steel coatings, steel tank coatings, tank coatings, time-tested

INTRODUCTION

In the mid-1990s, the US Navy's technical community, led by Naval Sea Systems Command (NAVSEA), recognized existing coatings used to protect the inside of ships' tanks were failing on average 5-8 years after application. The high cost to blast and recoat over 11,000 tanks every 5-8 years, not counting submarines and aircraft carriers, was prohibitive. To address this issue, the Navy conducted a study to analyze the problem and decided to replace these legacy coatings with high solid epoxy coatings.¹

Consequently, NAVSEA mandated high solid epoxy coatings in the tanks of ships, which would last 20 years. Initially, these coatings were referred to as high solids epoxy coating systems. Over time the high solids developed into ultra-high solids (UHS) and eventually 100% solids epoxy products.¹

Many of these tanks were inside of ships that are now decommissioned, but not all. Over 100 tanks with high solids coatings are estimated to still be in service. The Navy is currently collecting data on the condition of those tanks and looking to identify if the coatings lived up to the 20-year service life mandated by NAVSEA. Initial reports indicate that they have. Verbal reports from Navy officials indicate that high solid epoxy coatings have met the 20-year service performance criteria. It should be noted that NAVSEA refers to these coatings as single coat, rapid cure, MIL-PRF-23236D Type VII coatings. They do not make the distinction of the volume of solids content. The industry, however, offers the following distinctions:²

- **High Solids:** 50-60% solids
- **Ultra-High Solids:** 90% solids
- **100% Solids:** no solvents

It is worth mentioning that there have been significant improvements in the application procedures in addition to the materials. For example, with the implementation of the required UHS, the Navy implemented enhanced controls on coating application processes. Those processes included measuring and limiting soluble salt content on the substrate, confirming SSPC SP-10 near white metal blast substrate cleanliness condition, controlling relative humidity and tank temperature, and implementing quality control measures at each step. Each coating step had some quality control.¹

The Advantages of High Solids Epoxy Coatings

Formulas for coating products with less than 100% solids epoxy include solvents or thinners in the material to aid the application process. Epoxy has a very thick consistency, similar to molasses, and solvents serve to thin out the material to then be spray applied. However, thinners or solvents introduce a hazardous component to the epoxy product in the form of volatile organic compounds (VOCs), which are harmful to humans and the environment. Epoxies that are 100% solids are free of solvents making them safer for applicators and the environment.

In addition, there are many advantages to using these high solids epoxy coatings:

- Increased corrosion resistance, creating a more effective barrier. Tightly adherent, high solid epoxy coatings protect the substrate even in highly corrosive environments, including the harshest marine environments.
- Adhesion: when the substrate is prepared in accordance with Naval Standard Item 009-32 the high solids' adhesion performance is greatly enhanced.
- Single coat application offers a quick return to service with an average cure time between 4-6 hours.
- Capable of high build coating up to 500 mils (1/2-inch thick) in a single coat. Workers can spray up to 500 mils and the material doesn't run, drip, or sag.
- Edge retention reduces typical coating failure locations.
- Self-priming and no stripe coating necessary reduce the risk of delamination.
- Higher level of performance, offering over 20 years of extended service life to high-value assets.
- Wet film thickness (WFT) is equal to dry film thickness (DFT), which means there is no shrinkage and it's easier for applicators to apply the correct thickness.

US Navy Ship Seawater Ballast Tank Project

The Navy's Surface Maintenance Engineering Planning Program (SURFMEPP), a unit of NAVSEA, is responsible for tracking the status of over 11,000 tanks throughout the Navy except for submarines and aircraft carriers. Consequently, SURFMEPP maintains extensive databases to track the condition of these tanks. In 2005, NAVSEA and the NRL were involved in the laboratory testing of a 100% solid epoxy coating system. Following lab testing, NRL and NAVSEA set up an in-service test for the epoxy product inside the ballast tank of a US Navy ship. The existing coating in seawater ballast tank 3-121-1-W failed and the newly selected epoxy coating system was applied by an approved applicator company from Hampton, VA.