

# Use of coatings to control corrosion of maritime structures

**SSPC: The Society for Protective Coatings**, Pittsburgh, PA, USA

## Introduction

Structural steel is used in most maritime structures because it is strong, readily available, and not excessive costly. Unfortunately, marine environments present severe and costly corrosion problems for steel structures such as piling in port facilities. Protective coatings constitute the most cost-effective method of protecting marine structures from corrosion. They do this by providing a barrier between the steel and the aggressive marine environment.

## Severe marine environmental conditions

Marine environmental conditions that accelerate corrosion and degradation include moisture, salt water, oxygen, ultraviolet light, and high temperatures. These ambient conditions may not only significantly accelerate corrosion, but they may also degrade protective coating systems.

**Moisture:** Moisture in marine air often condenses on marine structures where it accelerates corrosion and deteriorates coatings. Thus, a coating system is required that will be impermeable not only to atmospheric moisture but also to water in which these structures may be immersed.

**Salt:** Salt is electrically conductive and thus promotes corrosion which is an electrochemical reaction. Because of the concern for salt contamination of cleaned surfaces prior to application of marine coatings, conductivity or other analyses for salt contamination are conducted to see if further cleaning is necessary before coating. Winds and waves can carry seawater onto steel decks, and winds can blow seawater spray onto all elevations of marine structures.

**Oxygen:** Surface marine waters are relatively heavily oxygen-laden compared to seawater at a greater depth, and oxygen greatly accelerates corrosion. Thus, corrosion of immersed steel marine structures is usually greatest in tidal areas.

**Ultraviolet light:** The sun's ultraviolet light can deteriorate some types of protective coatings used in corrosion control. Epoxy coatings are particularly susceptible to this type of deterioration. Fortunately, much of the coatings on maritime structures are not exposed to sunlight most of the time.

**High temperatures:** The rate of corrosion of steel almost doubles for every 10° C rise in temperature.

## Difficult marine working conditions

In addition to the corrosive properties of the marine environment, both it and the design of marine structures may also affect the working conditions in which coating operations must be conducted. Thus, there may be limited access to portions of maritime structures. There also may be limited deck space for compressors or other equipment that have a large 'foot print.'

The environmental conditions (e.g., wind and salt spray, fog, temperature) can change rapidly at marine locations, so that working conditions that were once acceptable, may not be. Mixed two-component coatings such as epoxies that were being applied can no longer be applied satisfactorily, and they thus constitute hazardous waste that must receive a proper and costly



Applying coating from cofferdam to quay wall of steel sheet piling.



Double-wall tanker in floating dry dock at on-shore facility.

disposal. Fortunately, some coatings (e.g., 100 per cent epoxies) can be formulated to be mixed at the gun and cure in a few minutes, so that these coatings are not so affected by changing weather.

## Coating systems for maritime structures

Coatings constitute the most commonly used and most effective method of corrosion control of marine structures. However, they are only effective if the proper coating system is selected for the specific environment and applied to a properly prepared surface. Also, the coating materials and operations must conform to all OSHA safety requirements and all EPA environments requirements.



On-shore marine facilities.

## Selection of coating system

The September 2006 issue of SSPC's Journal of Protective Coatings and Lining contains listings of many different generic coating systems available from coating manufacturers for service in different marine environmental areas. Only the most commonly used systems on these listings will be discussed here.

**Atmospheric service:** The most commonly listed, and probably the most commonly used, generic coating system for maritime atmospheric service in sunlight is one or two coats of epoxy (depending upon the coating thickness) for barrier protection and one coat of aliphatic polyurethane for protecting the epoxy from the sun's ultraviolet light. Two or more coats of epoxy can be used on structures that are not exposed to sunlight.

A slightly more costly system of one coat of zinc-rich primer, one coat of epoxy, and one coat of aliphatic polyurethane may provide better performance in more aggressive services.

**Intertidal and splash zones:** The above coating systems for the atmospheric service are frequently used in the intertidal and splash zones. However, a finish coat of flake-filled epoxy may provide better impact and abrasion resistance.

Monel cladding extending to about 20 feet below water is also occasionally used in these areas. It provides resistance to marine fouling organisms, as well as protection of the steel from corrosion.



Launching of ferry.

**Immersion Zone:** The immersed areas of maritime structures are most commonly coated with one or two coats of 100 per cent solids epoxy or three coats of solvent-borne epoxy. Polyamide-cured, solvent-borne epoxy coatings have excellent water resistance and are somewhat tolerant of incompletely cleaned steel surfaces.

Coal tar epoxy coatings have very good water resistance and one or two-coat systems are also often used on immersed areas of steel.

Commercial and Navy ships must use antifouling coating in immersed areas to prevent drag and extra fuel consumption. These are not usually required for marine piling and other immersed marine structures.

Cathodic protection systems that place an electrical potential on the steel are often used to protect immersed portions of maritime structures. An impressed current cathodic protection system that utilises an external DC power source usually works best on immersed steel in seawater.

Cathodic protection works well in conjunction with protective coatings. The coatings greatly reduce the amount of current needed for cathodic protection and the cathodic protection arrests corrosion at imperfections (holidays) in the coating. As the immersed areas of coating slowly degrade, the cathodic protection is increased to provide additional protection.

Because normally immersed areas can be protected cathodically and atmospheric areas of damaged coating are accessible for repair, damaged coatings in the intertidal area are the most difficult to repair. They can best be repaired by abrasive blasting (with debris containment) and coating with a quick-curing epoxy coating between tidal changes or by making repairs in a cofferdam.

## Shop coating of piling and other maritime structures

Steel piling and other maritime structures are best abrasive blast cleaned coated in a shop with controlled environmental conditions and good access to the work. Some coating damage may occur during shipment of the components and their installation, and this will require touch-up. With all coating systems, the



Salt water corrosion of boarding area on offshore platform.

recommendations for surface preparation and application in the manufacturer's product data sheet must be followed carefully in order to receive optimum coating performance.

**Surface Preparation:** For coatings to perform successfully on steel maritime structures, it is necessary to first prepare the surface for coating application. Surface preparation includes cleaning both to (1) remove contaminants that would initiate coating deterioration and steel corrosion and (2) roughen the surface for good primer adhesion. Areas exposed to sea water immersion or marine atmospheric environments should be blast cleaned to a near white finish (SSPC SP 10/NACE 2). Open abrasive blasting is not permitted in many locations, so that it may be necessary to contain the dust and debris that is generated or use a vacuum blast system that collects the spent contaminated abrasive.

**Coating Application:** Coating application is almost always done by airless spraying. A plural-component spray unit must be used for applying coatings with a very short pot life. Thickness and other application requirements are provided by the coating manufacturer.

## Summary

Coating systems are available for providing long-term protection to maritime structures. They protect immersed areas very well when used in conjunction with cathodic protection. Optimum coating performance is contingent on selection of an appropriate system, proper preparation of steel surfaces, and careful coating application.

### ABOUT THE ORGANISATION

SSPC was founded in 1950 as the Steel Structures Painting Council, a non-profit professional society concerned with the use of coatings to protect industrial steel structures. In 1997, the name of the association was changed to The Society for Protective Coatings to better reflect the changing nature of coatings technology and the ever-expanding types of construction materials.

SSPC is the only non-profit association that is focused on the protection and preservation of concrete, steel and other industrial and marine structures and surfaces through the use of high-performance industrial coatings. SSPC is the leading source of information on surface preparation, coating selection, coating application, environmental regulations, and health and safety issues that affect the protective coatings industry.

### ENQUIRIES

SSPC: The Society for Protective Coatings  
40 24th Street, 6th Floor  
Pittsburgh PA  
15222-4656  
USA

Tel: +1 (412) 281 2331  
Toll-Free: +1 (877) 281 7772  
Fax: +1 (412) 281 9992  
Website: [www.sspc.org](http://www.sspc.org)